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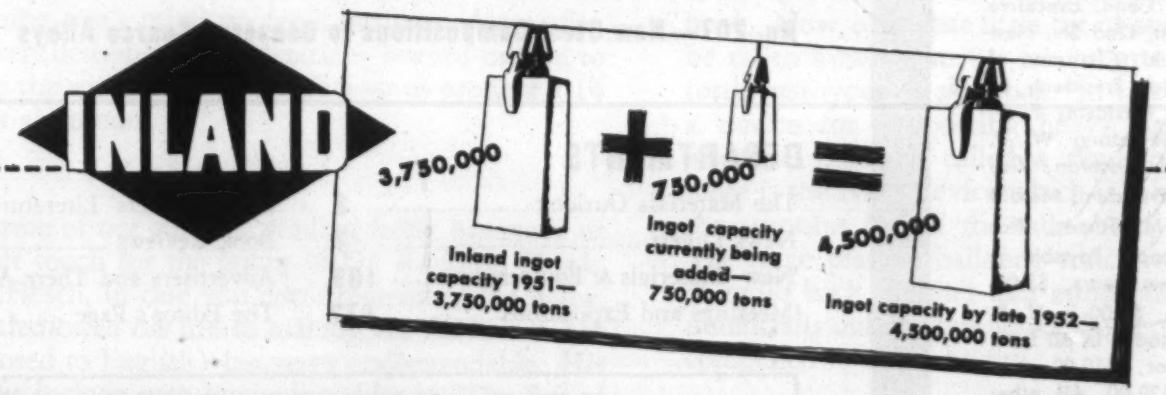
It's the fellow with the long white whiskers and the "DO" engraved on his brief case. He's asking for a lot of our steel. And he's getting it.

While his purchases may hurt some of our regular customers, we're far from reluctant to help him out . . . for we want him to be ready to do whatever is required, if and when Uncle Joe starts the fireworks.

In the meantime, we're building so that he, and all of our friends in the midwest, will have more steel.

More scrap from you... means more steel for you



INLAND STEEL COMPANY. 38 South Dearborn Street, Chicago 3, Illinois

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The Materials Outlook

If no definite announcement of a Controlled Materials Plan has been made before this appears in print, it is almost a certainty that there will be no such plan until fall—if, indeed, there will be one at all. There seems to be a strong feeling against controls among many powerful people in Washington.

> According to some spokesmen, most controls should be ended in about two years, barring war on a larger scale than that which now engages us. Others claim it will take about four years for our economy to expand sufficiently to encompass the needs of civilians and the military with little or no restriction.

One of the most serious shortages now facing a rapidly expanding steel industry is that of scrap. There has been no determined effort to recover scrap either in this country or in the storage areas of the last war. Estimates place the amount of scrap steel available on one island in the South Pacific at better than 400,000 tons. The same situation prevails in many parts of the world. One of the largest mines of scrap is the sea coast off Normandy where countless ships and landing craft were sunk during the invasion.

> Some industry leaders are reaching the conclusion that this country would be wise to institute a permanent scrap reclamation program designed to help us overcome the mounting deficit in many metals. Tin, copper and chromium would be among the first metals included in any such program. Barring any unanticipated stores of these and several other metals, we are to be at the mercy of other countries for these materials from now on. Higher prices, which will certainly prevail, should spur the scrap recovery.

A new source of iron powder suitable for making sintered iron rotating bands for shells is being developed in northwestern New Jersey. A pilot plant is already in operation using ores found in that area. This is said to be the first time that iron powder of a quality suitable for powder metallurgy has been produced from a domestic ore. Since the success of the process has been proved by the pilot operation, a commercial plant is now being designed. As yet no capacity has been announced for the new facility.

(Continued on page 4)

The Materials Outlook *(continued)*

Leaders of the plastics industry are issuing fervent warnings that plastics should not be considered as substitute materials for steel and aluminum at this time, when the uses of those metals are being restricted. As a matter of fact, the plastics people point out, plastics have many war and defense duties of their own --sufficient to create scarcities in many of the most useful plastics. Limiting the further expansion of the most critical plastics is the shortage of benzol, a chemical essential to the manufacture of phenolic and styrene plastics.

Current army orders are said to involve about 75,000 lb of titanium metal, which will be delivered at a cost of about $1 million. Estimates of 1950 production of the important new metal range between 100,000 and 200,000 lb.

Speaking of titanium, pressure from all directions is being applied on titanium producers to make them expand capacity by many times. There are a few hitches, though. First, producers of sponge are reluctant to make major investments until there is some assurance of future markets. More important is the fact that all present methods of making titanium sponge are expensive and it is expected that someone someday will come up with a simplified method that would obsolete all current facilities overnight.

The new boron treated steels are causing a furor, to say the least. Acceptance is at a stand-off. Many large users have accepted the steels with complete enthusiasm, while others turn their noses up at them. Part of the difficulty in the latter cases stems from past sad experiences. More and more steel companies are considering the production of the steels as now tentatively standardized by the AISI.

An unexpected development in connection with the boron steels is a stampede for the modified 8600 series steels. The modifications involve a reduction in the molybdenum content and an increase in the chromium content of the steels. In some respects the modification has been a case of robbing Peter to pay Paul, for both molybdenum and chromium are in critically short supply.

Straws in the political wind indicate that some State Department officials as well as Defense Department planners would like to ease up on our armament program. The idea is not to reduce the amount of manpower or material, but to build up to desired strength in four or five years rather than in two or three. The undercurrent of feeling is strong, despite the flurry of propaganda having the opposite implication, which will come from Washington until such time as Congress passes the next appropriations bills.

News Digest

Boron Steels Go into Production

The new boron alloy steels which have been developed by the steel industry to conserve three critically short alloying elements have gone into commercial production. Some steel has been rolled and shipped to the automotive and agricultural industries.

The new steels promise to be about 5 to 6% cheaper than the standard grades they replace, and are designed to curtail the use of nickel, chromium and molybdenum by about 50%.

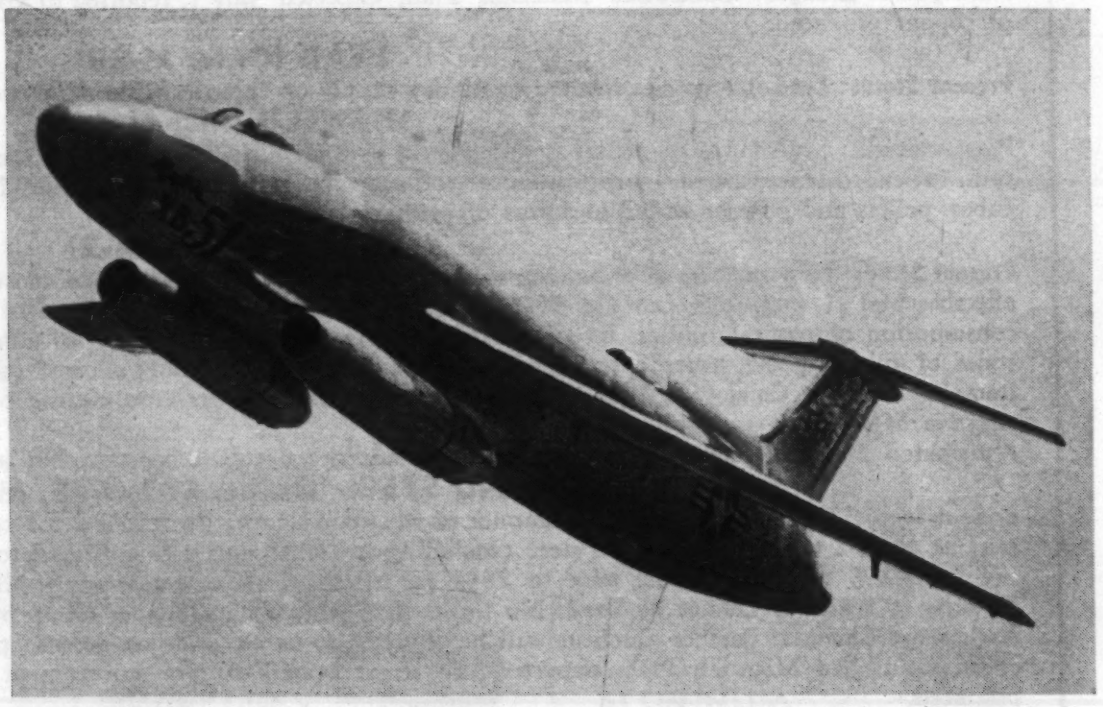
Five companies—United States Steel, Bethlehem, Youngstown Sheet and Tube, Crucible and Wisconsin Steel, a subsidiary of International Harvester—turned out the initial batches of the new alloys. Each made two heats of 150 tons each, or a total of 1500 tons. Eventually 12 to 15 steel companies will be producing the new alloys.

Identity of the automotive and agricultural implement companies receiving the first shipments has not been made public, but it is understood that the steel will be used in automotive gears, engines and transmissions, and in structural parts of farming equipment.

Consumer response to these new steels, according to reports, has been "terrific." Ever since the announcement of the development of the steels a few days ago, members of the technical committee of the steel industry responsible for the discovery have been deluged with calls from all over the country for additional information about possible uses for the new alloys.

It is apparent that they are getting a more enthusiastic reception than even the national emergency steels developed during World War II. The latter steels likewise were developed to conserve critical materials and were found so satisfactory that not only are they still being made, but their use has also increased by about 45% since the start of the Korean war.

One of the principal inquiries made by steel consumers concerned the availability of boron, which is used to treat the alloys. An abundant element in this country, boron comes principally from Death Valley, Calif.



Critical chromium, nickel and molybdenum will be released by new boron alloy steels for military applications like this Martin ground-support jet.

The amount of it contained in the new alloys, according to the steel industry's technical committee, is 2/1,000 of 1%.

Replacement of Steel Grades

In answer to the other principal query on the new steel alloys, the committee issued the following statement:

"Standard carburizing (case hardening) grades of all steel can be replaced by one of the new steels of the following chemical composition: Carbon, 0.17 to 0.23; manganese, 0.45 to 0.65; chromium, 0.15 to 0.35; nickel, 0.20 to 0.40; molybdenum, 0.08 to 0.51%; plus boron. The standard steels which can be replaced by that composition are 1320, 2515, 3120, 4118, 4620, 5120, 8620 and 8720.

"In order to replace standard grades 4023, 4027 and 4028, no boron is required, but the carbon content of the new steel must be increased to 0.19 to 0.25% and 0.23 to 0.30%, respectively. The latter steel contains sulfur to enhance machinability. Standard steel 4320 can be replaced by standard steel 9417 plus boron.

"Standard full hardening grades of alloy steel can be replaced by one of the new steels of the following chemi-

(*Continued on page 9*)

Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Feb. 15, 1951 through Mar. 15, 1951.

ALUMINUM (Orders M-5, M-7, M-22, M-27)

Present Status: Quantity of aluminum any person may use during calendar quarter commencing Apr. 1 set at 65% of average quarterly consumption during first six months of 1950. Percent of total monthly production primary producers must accept in rated orders raised to 11½%; primary fabricators must accept up to 45%. Items on List A may be manufactured by a producer having the materials in inventory on Apr. 1 if the materials are unsuitable for use by him in any product not on the list.
Items in Which It Cannot Be Used: Aluminum windows and air ducts after June 30.
Anticipated Changes: Revision of aluminum distribution order to provide more equitable flow to distributors and jobbers. Controlled Materials Plan, expected July 1, reported to give government strict control over 40 to 50% of aluminum produced.

ANTIMONY (Order M-39)

Present Status: Inventories limited to 60-day supply or "practical minimum working" supply. Does not include ores or concentrates.

BISMUTH (Order M-48)

Present Status: Use prohibited for purposes other than those specifically permitted. Inventories limited to 30-day supply or practical minimum working supply. Items being processed Apr.1 may be completed and sold if processing is finished Apr. 30. Producers must accept rated orders up to 50% of scheduled production in any one month in terms of bismuth content. Dealers must accept rated orders up to 25% of total weight of bismuth products available to them in any one month.

COLUMBIUM (Orders M-3, M-49)

Present Status: Delivery of columbium, ferrocolumbium and columbium stabilized steels (mill products and castings) prohibited except as specifically authorized by NPA. Deliveries of columbium-bearing scrap exempted if suitable for remelting. Content of columbium or columbium-tantalum for producing stainless steel cut to 8% of carbon content of steel.

COPPER (Order M-12)

Present Status: Copper held in inventory after Mar. 1 may be used for manufacture of items on Lists A and B if unsuitable for use by manufacturer for making other products. During quarter commencing Apr. 1: production of brass mill and copper wire mill products limited to 80% of average quarterly production during first six months of 1950; foundry products limited to 100% of average quarterly production during base period; no person may use specified copper forms and products in excess of 75% of average quarterly use in base period.
Some Items in Which It Can Be Used: Brass plating on all listed items of builders' hardware where other finishes are unsatisfactory (previously prohibited).
Items in Which It Cannot Be Used: (List B) Builders' hardware, building materials, clothing accessories, household electrical appliances (except for parts where copper is essential), non-functional refrigeration and air conditioning equipment.
Anticipated Changes: Controlled Materials Plan, expected July 1, reported to give government strict control over 40 to 50% of copper produced.

LEAD (Order M-38)

Present Status: Lead inventories limited to 60-day supply or "practical minimum working" supply.

NICKEL (Order M-14)

Present Status: Inventories of nickel, stainless steel or high nickel alloys may be used for items on List A of prohibited products until expended if not usable by the producer for authorized products. Inventories limited to 30-day supply. Nickel rondelles, cubes, pellets and powder added to forms of primary nickel under control.

RUBBER (Order M-2)

Present Status: New method of allocating rubber effective Feb. 19 reduces base consumption of new rubber. Under this method, effective Mar. 1, consumer can use 95% of adjusted base period consumption of new rubber, 48% of adjusted base period consumption of natural rubber. Effective Apr. 1, consumer may use 114% of adjusted base consumption of latex. Types and styles of rubber goods ordered reduced in number. Black rubber only allowed for all except specified items.
Items in Which It Cannot Be Used: 32-page list of rubber end products cutting or eliminating their natural rubber content effective Mar. 1.
Anticipated Changes: Heavy demands may bring additional cuts in consumption later this year.

IRON AND STEEL (Orders M-1, M-3, M-6, M-20)

Present Status: Commencing Feb. 15, amount of steel products to be reserved for rated orders raised, increases in percentages ranging from 2 to 25% on carbon steel (including low alloy and high tensile) products. As of Mar. 12, further increases ranging from 5% for carbon steel wire to 28% for electrical sheets and strips of alloy steel became effective.
Products in Which It Cannot Be Used: No limitations other than shortages set up by DO reservations.
Anticipated Changes: Further amounts will be required to be set aside as defense programs expand and the MRO plan takes effect. Controlled Materials Plan, expected July 1st, reported to give government strict control over 40 to 50% of steel produced.

TANTALUM (Orders M-3, M-49)

Present Status: Delivery of tantalum, ferrotantalum and ferrocolumbium-tantalum prohibited unless authorized by NPA. Deliveries of tantalum-bearing scrap exempted providing scrap is suitable for production of tantalum-bearing steel. Stainless steel limited to columbium-tantalum content of eight times the carbon content of the steel.

TIN (Orders M-8, M-24, M-26, M-27)

Present Status: During quarter commencing Apr. 1, no person may use tin or terne plate in any month in excess of 95% by weight of average monthly use of pig tin for this purpose in the base period; nor may any person use for any purpose other than those mentioned an amount of pig tin in excess of 90% by weight of average monthly use during base period.
Some Items in Which It Can Be Used: Previously prohibited, tin may now be used in cans for: frozen and processed orangeade and pineapple juice concentrates; hams; gravies; spaghetti and meat balls; aerosol and lighter fluid. Also may be used in items such as dental foil, lead-base foil for burglar alarms and tin oxide for laboratory agents and medicinals.

ZINC (Order M-37)

Present Status: Use of zinc dross limited to production of zinc dust unless written authority is granted by the NPA.

Maintenance and Repair Order

NPA Regulation 4 (MRO order) permits allocation of essential materials for purposes of maintaining and repairing manufacturing installations and equipment, regardless of their products.

l composition: carbon, 0.36 to 0.44; anganese, 0.70 to 1.00; nickel, 0.20 0.40; chromium, 0.15 to 0.35; olybdenum, 0.08 to 0.15%; plus oron. The standard grades which n be replaced are 1340, 4047, 4640, 140, 8640, 8740 and 9440. In order replace grades 3140 and 4140, it is ecessary to increase the chromium ontent of the new steels to 0.30 to 55%.

"The heat of these new steels is ssentially the same as that for the andard grades, with the exception at they should be quenched about 5 deg higher and tempered about 5 deg lower." (See *Engineering File acts* No. 207, p 105, for composition new steels.)

World's Largest Molding Line

The world's biggest production line r large injection molded plastic parts ecently went into action at General merican Transportation Co.'s new ctory in East Chicago, Ind. Typical arts being molded are refrigerator eezer chest doors, humidifier draw-s, and TV windows. For such pro-uction, giant injection molding ma-hines weighing over 100,000 lb each e required. Molds are squeezed with 000-ton pressure. The force required squirt the hot plastic into the chilled old is 20,000 psi.

Five of these big machines, each apable of molding 60 oz. of plastic aterial per cycle, are at work in eneral American's **new plant. These** uge machines were designed and uilt by The Hydraulic Press Manu-acturing Co., Mount Gilead, Ohio, nd incorporate features which permit production cycle of normally less han 1 min.

Only 15 years ago, 2-oz moldings — such items as knobs, ornamental ewelry, dials, etc. — were considered rge molding jobs. Now, with giant ydraulic injection machines, parts eighing up to 300 oz can be pro-uced at rapid rates. Injection mold-ng of plastics has experienced a henomenal growth. Production is ast, materials are stable, and there is ractically no limit to colors which an be obtained.

Probably the greatest single factor n the tremendous acceptance of the ermoplastics is that injection molded arts require little or no finishing, thus eeping labor costs to an absolute inimum.

Prior Stress Effects on Aluminum Fatigue

The life of aluminum alloys that are subjected to vibration and other repeated or fluctuating stresses may be materially affected by applying stress to the material before it is placed in operation. Recent investigations at the National Bureau of Standards have shown that this treatment, known as prestressing, in some instances increased the fatigue life manyfold. This was especially noticeable at lower stresses when a comparatively small number of cycles of dynamic prestresses were applied. On the other hand, there were cases in which little if any improvement resulted, and at some stresses the fatigue life was shortened by the prestress.

These studies were carried out by J. A. Bennett and J. L. Baker in the Bureau's mechanical metallurgy laboratory to evaluate the effects of both static and dynamic prestress on the fatigue properties of structural aluminum alloys. Similar studies have been previously made on aircraft steel.

One of the difficulties encountered in applying results of laboratory tests to practical construction arises from the fact that, in many structures, the stresses vary in a random manner. An airplane wing, for example, must support not only the weight of the plane, which is a steady load, but also a fluctuating load due to vertical gusts. To approximate this situation, the cumulative effect of fatigue stressing at two or more different amplitudes was evaluated, using aluminum alloy sheet specimens.

Two means of prestressing were employed. In the first, a rather high static load was applied to the specimen before the start of the fatigue test. In the second, the specimen was stressed in the fatigue-testing machine for a predetermined number of cycles at one amplitude, and then carried to failure at a second amplitude.

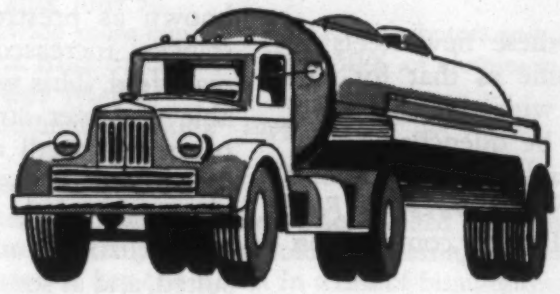
The static prestress studies were made with Alclad 24S-T sheet, and all fatigue tests with this group of samples were operated in unidirectional bending; that is, the specimen was bent in only one direction from the "no load" position. First, a sufficient number of specimens were tested

(*Continued on page 11*)

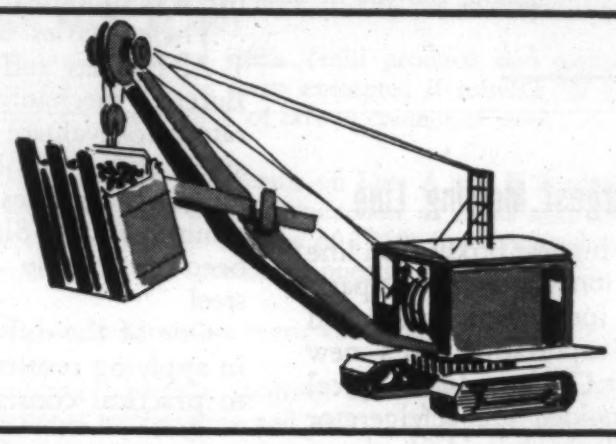
Matter of Fact
BY EDWARD A. JOSEPH
U.S. RAILROADS USE MORE THAN
95 MILLION WOOD TIES
ANNUALLY
THERE ARE ABOUT
3000 TIES
TO THE MILE
AUSTRALIA'S WORLD WAR II MEMORIAL TO THE UNITED STATES, TO BE CONSTRUCTED IN 1951, WILL CONSIST OF A SINGLE, 250 FOOT SHAFT OF
ALUMINUM
TOPPED WITH A BRONZE EAGLE
DRAWINGS
MADE BY AUTO DESIGNERS AND ENGINEERS OFTEN REACH AS HIGH AS
1500
DIFFERENT SKETCHES IN THE DEVELOPMENT OF A NEW BODY STYLE
FOR EVERY SINGLE COMPANY IN THE MINING AND MANUFACTURING FIELDS THAT HAS DISAPPEARED THROUGH MERGER DURING THE PAST
EIGHT YEARS,
FORTY
MORE THAN NEW COMPANIES HAVE BEEN ESTABLISHED

make it
STRONGER

make it
LIGHTER



make it
LAST LONGER



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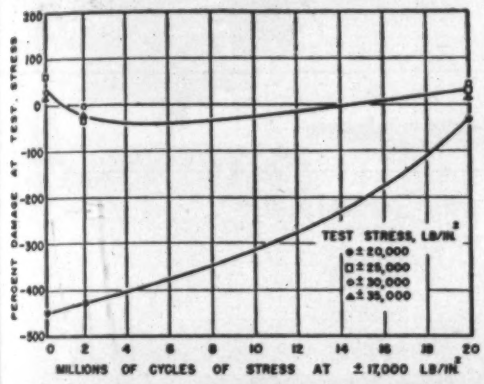
without prestress to give the typical relationship between stress amplitude and number of cycles to fracture for the original material. Then a static load was applied to the remainder of the specimens before starting the fatigue test. In some cases the bending load in the fatigue test was in the same direction as the static load; in others these directions were opposite.

At the higher test stresses (25,000, 30,000 and 35,000 psi), the effect of the static prestress was negligible.



Effect of dynamic prestressing at 17,000 psi on fatigue strength of 24S-T aluminum-alloy sheet. Specimens were stressed at 17,000 psi in the fatigue-testing machine for a given number of cycles (plotted along the abscissa) and were then carried to failure at another stress.

However, at the test stress of 20,000 psi, there was an appreciable decrease in life for the specimens with a prior static stress in the same direction. The new result was a 10-to-1 difference in life between these two sets of specimens.

The tests for evaluating the effect of dynamic prestress were made on specimens of bare 24S-T sheet. The fatigue loading was applied in completely reversed bending. That is, the specimens were deflected equally to each side of the no-load position. The prestress amplitude was applied for a given number of cycles before the specimen was carried to failure at the test stress. Three values of prestress amplitude were used and four test stresses.

At the two higher prestress amplitudes (22,500 and 32,500 psi) fracture occurred earlier in the prestressed samples than in the original material. It seems, therefore, that a portion of the fatigue life of the alloy is used up by the prior stress. Within experimental error it was found that

(*Continued on page 142*)

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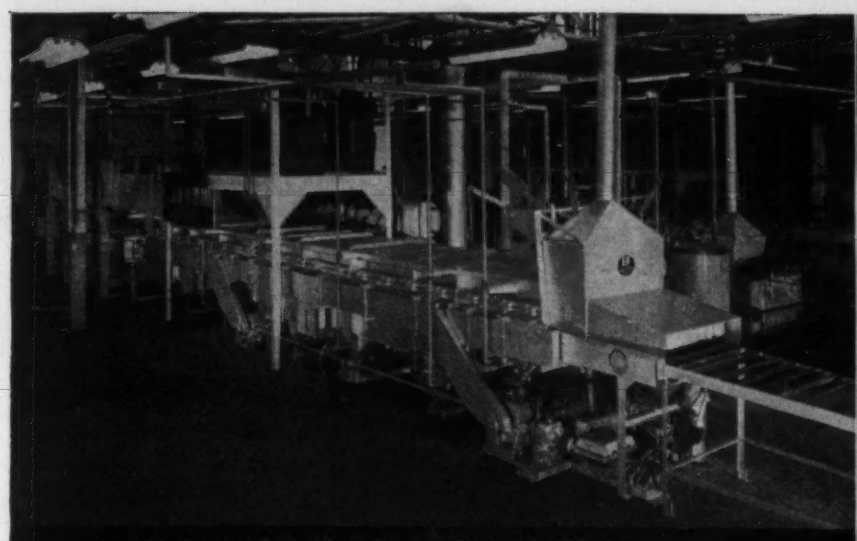
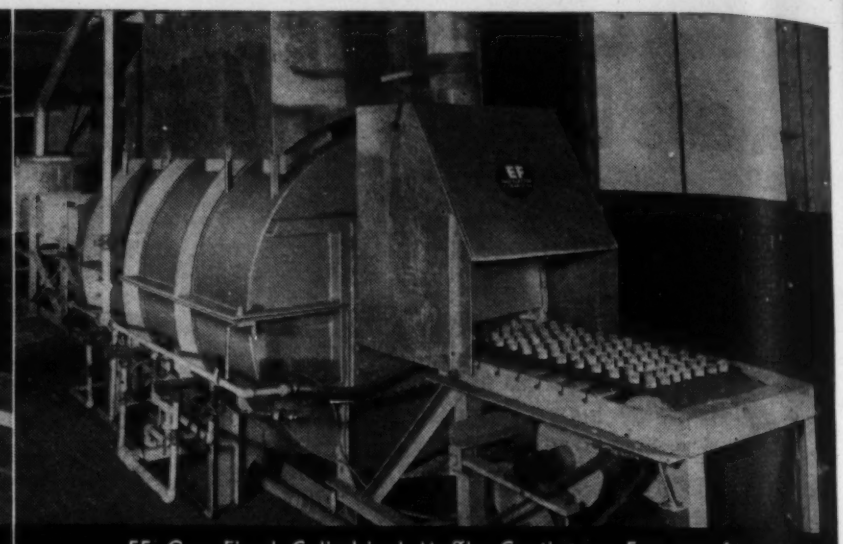


Discharge End of a Large Capacity EF Combination Gas Fired and Electric Sintering Furnace, 60' long.



EF Gas Fired Cylindrical Muffle Continuous Furnace for Sintering Nonferrous and Iron Powder Parts.

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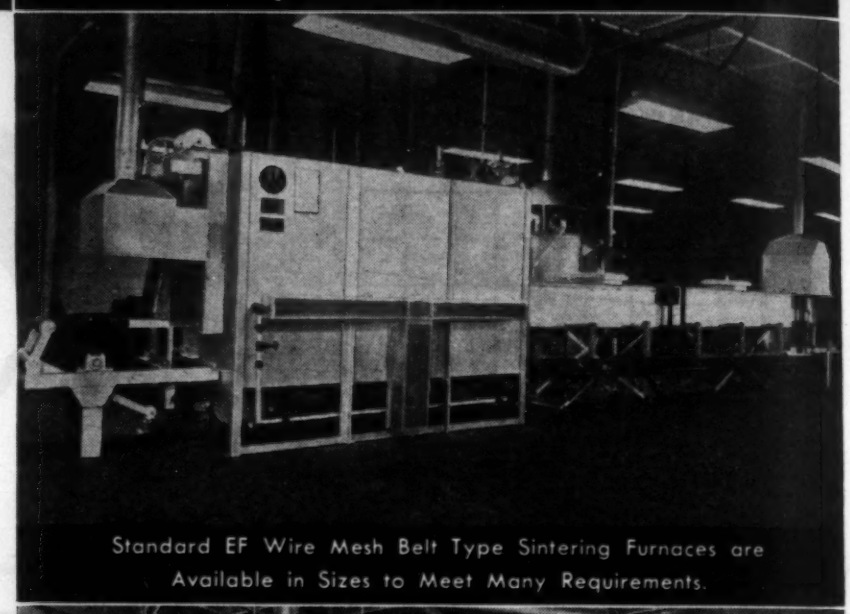
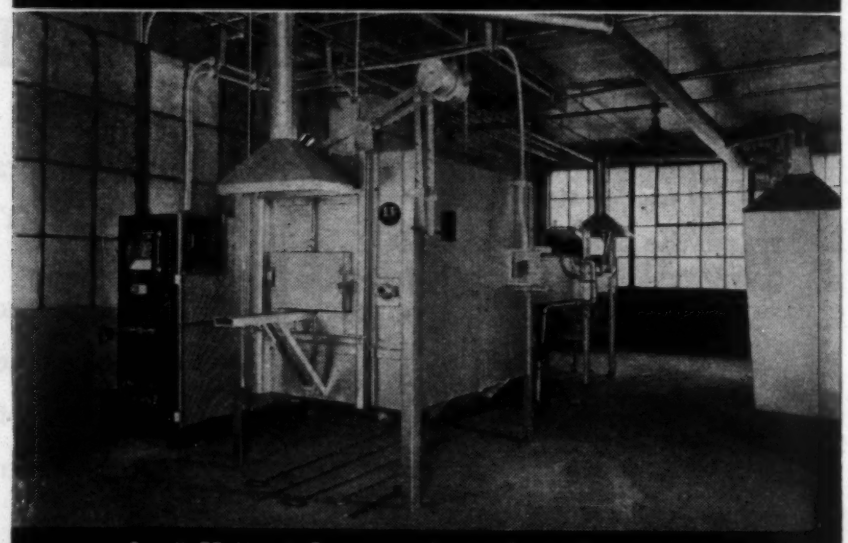
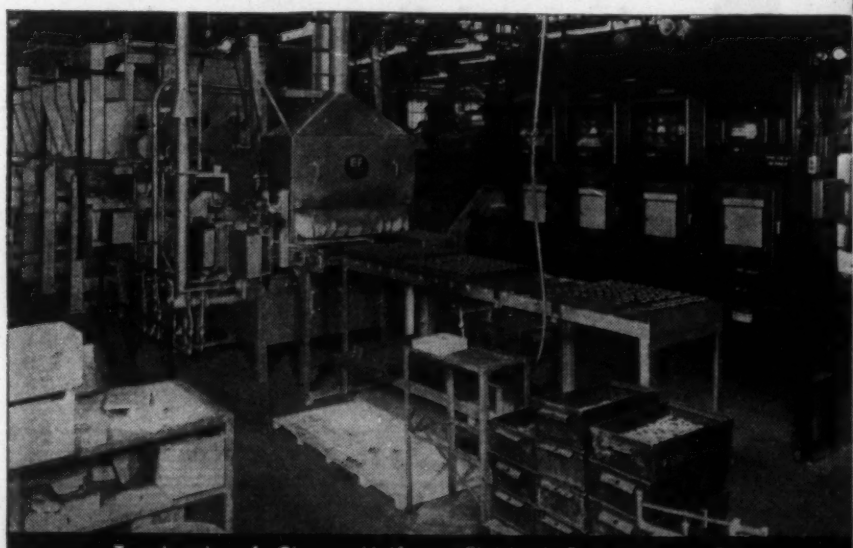
Gas Fired, Oil Fired and Electric Furnaces
For Any Process, Product or Production



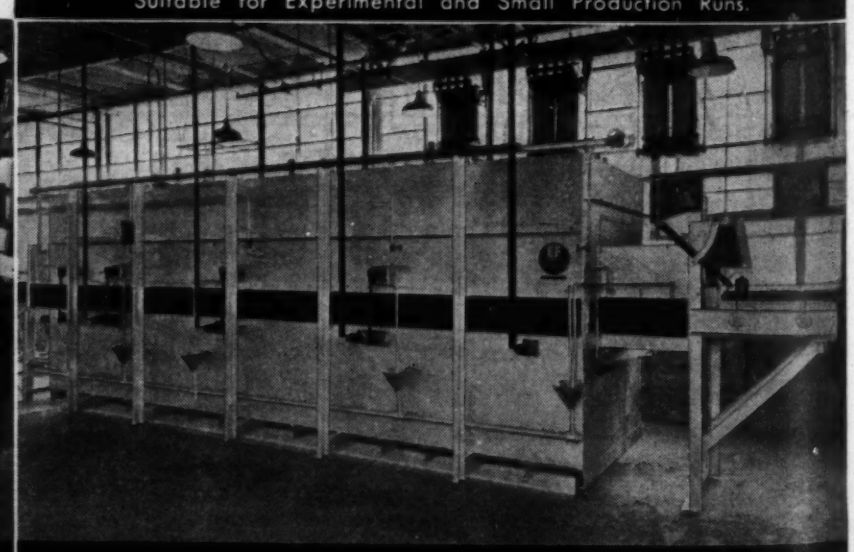
Standard EF Wire Mesh Belt Type Sintering Furnaces are Available in Sizes to Meet Many Requirements.



Small EF Hand Operated Pusher Type Electric Furnace Suitable for Experimental and Small Production Runs.



Trayloads of Clean, Uniform, Finished Parts Leave This EF Gas Fired Furnace — Continuously and Automatically.



Metal Powder may be Fused on Six 3'' Strips of Steel, Simultaneously and Continuously, in this EF Furnace.

PREVIEW

1951 Metal Powder Show and Seventh Annual Meeting

The role of powder metallurgy in the present defense program will be the theme of the 1951 Metal Powder Show, to be held on Apr. 25-26 in Cleveland, at the Hotel Cleveland. The Show and Meeting, as in the previous six years, will be sponsored by the Metal Powder Association, and is open to everyone interested in any phase of powder metallurgy. Besides the important technical program, there will be exhibits by leading metal powder producers, metal powder parts fabricators, and equipment manufacturers.

As mentioned above, the technical program will be devoted principally to the developments and activities of the powder metallurgy field in the defense effort. Leading authorities in powder metallurgy and the government will present papers on this vital subject. Among the subjects to be covered are the status of the Army's iron powder rotating band program, and the possible use of metal powders in small arms ammunition. The activities of the American Ordnance Association Powder Metallurgy Committee will also be described. In addition, there will be papers on use of metal powder parts as substitutes for critical materials in household appliances, and on uses of powdered iron materials in high frequency transformers for military equipment.

All technical sessions will be held in the meeting room (Ballroom) adjacent to the exhibits in the Hotel Cleveland.

Besides the technical program, there will be a reception and buffet supper and a luncheon featuring a well-known speaker, who will discuss a subject of timely concern to the industry.

The exhibits at the show will feature the latest developments of leading producers of metal powders, fabricating equipment, and products made from metal powders. The displays will be shown in the Red Room (Hotel Cleveland) from 9:00 A.M. to 7:00 P.M. on Wednesday and 9:00 A.M. to 5:00 P.M. on Thursday.

Program

Tuesday, April 24

2:00 P.M.

Meeting of Metal Powder Association Standards Committee.

Wednesday, April 25

10:30 A.M.

Powder Metallurgy Committee of the American Ordnance Association Shell Committee, Their Functions and Activities —A. J. Langhammer, Amplex Mfg. Co.

A study of plant and manufacturing facilities available and on order for immediate requirements of bushings, bearings and finished machine parts has been made, along with a study of presses and equipment for producers of metal powder products, if additional units should be required. A study of capacity and expansion programs for producing iron powder has also been undertaken.

11:15 A.M.

The "Flywheel" Effect in Infiltrated Metal Powder Parts—George Stern, American Electro Metal Corp.

A "flywheel" effect is shown to exist in copper infiltrated iron powder parts. Infiltration strengthens low density areas in normal powder metallurgy products and makes part capable of sustaining high stresses.

2:30 P.M.

Powdered Iron Materials in High Frequency Transformers for Military Equipment—H. W. Lord, Chairman, Sub-Panel on Coils, Inductors and Transformers, Panel on Components, Committee on Electronics, Research and Development Board, Department of Defense.

Description of the contribution of powdered iron materials to the miniaturization of high frequency transformers. Transformers are often the largest component of electronic amplifiers; hence, a reduction in their size plays an important part in the miniaturization of military electronic gear.

3:15 P.M.

Metal Powders in Some Small Arms Ammunition Applications—Col. G. A. Miller, Jr., Frankford Arsenal.

4:00 P.M.

Sintered Iron Rotating Bands and Cemented Carbide Cores for Ordnance Use —A. M. Burghardt, Watertown Arsenal.

The present status of sintered iron powder rotating bands in this country will be reviewed and some comments presented concerning utilization of cemented carbides for core use.

5:30 P.M.

Reception—Cocktails and Buffet—Ballroom.

(*Continued on page 15*)

We're Making It Again!

Metals Disintegrating Company resumes manufacture of Iron Powder - - May 1951

Prior to World War II, all Iron Powder used in this country came from abroad. In 1939, the Metals Disintegrating Company entered into the manufacture of Iron Powder, continuing to supply the many wartime and other industrial needs for this product during the following eight years.

In 1947, when the market and demand for Iron Powder had slackened considerably, MD withdrew from the manufacture of this product, announcing these reasons for so doing and advising that if, and when, market conditions and demand again warranted it, MD would then resume this manufacturing.

With the present troubled world conditions, there is again an increased need for Iron Powders. Therefore, MD is now going back into the production of this product.

This is but another phase of MD's varied activities in the field of Metal Powder manufacture, an extensive experience made possible by a 35-year background of development and accomplishment. Laboratory, research, development and increased production capacities have all combined to provide the utmost utilization to the user of Metal Powders.

It is this experience and proven ability which now place MD in a position to contribute to the defense effort as well as the other needs of Industry, wherever such services may be useful, with a full assurance of responsibility and complete dependability.

METALS DISINTEGRATING COMPANY, INC.

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1249

MD POWDERS

Products

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BRASS
BRONZE
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CHROMIUM
COPPER
IRON
LEAD
MAGNESIUM
MANGANESE
NICKEL
PHOSPHOR COPPER
SILICON
SILVER
SOLDER
SPECIAL ALLOYS
TIN
ZINC

These powders are manufactured in granular, nodular, spherical and flake forms in various particle sizes.

METAL ABRASIVES

Special Heat Treated Shot

Heat Treated Diamond Grit

MD POWDERS

Since 1916

METAL POWDERS
METAL PIGMENTS
METAL ABRASIVES

WORLD'S LARGEST MANUFACTURER OF FINELY DIVIDED METALS

Shell Rotating Bands Successfully Made From Iron Powders

Large scale adoption of iron powder rotating bands is now a definite possibility and will make possible large savings of critically short copper.

by H. R. CLAUSER, Managing Editor, Materials & Methods

• WHAT MAY PROVE TO BE one of the most important technical achievements of the present defense effort is the development and adoption of sintered iron powder rotating bands for projectiles. The far-reaching significance of this development is evident when we consider the saving of thousands of tons of copper, already in short supply, that would result from large scale adoption of iron powder rotating bands. But, in addition to the savings in copper, there are definite indications that sintered iron bands perform better than copper, particularly on high velocity projectiles.

Development History

Credit for the initial development and use of sintered iron rotating bands goes to German technicians. The extreme shortage of copper in Germany led to the use of porous iron as a substitute material, and during the latter part of the war, sintered iron bands were universally adopted for all normal velocity projectiles from 20 to 210 mm in size. To give some idea of the extent to which sintered iron rotating bands were used by the Germans, in two plants over a period of about five years a total of 190 million sintered iron bands were produced, involving about 15 million lb of iron powder. Reliable estimates place the total amount of iron powder used by Germany for rotating bands at 100,000 tons.

Although iron powder bands were originally adopted to save copper, the Germans found that they were in many respects superior and less costly than copper.

The successful use of porous iron rotating bands by the Germans provoked considerable interest in this country during and after the war. The Army Ordnance Corps, therefore, undertook to make a thorough investigation of their potentialities. Watertown Arsenal was given the prime responsibility for research programs in this field. Since major difficulties were being encountered with copper rotating bands on 3 in. and larger caliber projectiles for high velocity use, emphasis has been devoted to the application of sintered iron rotating bands on these items. The preliminary results of the investigations indicate that rotating bands made from iron powder perform satisfactorily on high velocity projectiles, and funds have been allotted for the procurement of a large number of bands in the near future.

Preliminary tests are now underway also on bands for normal velocity projectiles. If the results prove promising, more extensive tests will be made, and these might possibly lead to large scale use of sintered iron powder bands.

Properties of Iron Powder Bands

The main characteristics required of projectile rotating bands are well known. They must have sufficient ductility to flow properly when swaged into the projectile band seat and not crack in the process. They must have such characteristics as to permit engraving by the gun rifling without excessive wear of the gun tube. They must have sufficient strength to resist being sheared off in the gun tube or dislodged during flight. They should provide a good seal with the rifling to prevent escape of gas by the projectile and consequent lowering of pressure. They must also have reasonable corrosion resistance under the storage conditions likely to be encountered in service.

At first glance it would appear that, compared with gilding metal, sintered iron powder rotating bands would fail to meet at least some of the requirements. However, the German work and our own studies indicate that iron powder bands can be designed to meet these requirements satisfactorily.

Highly porous iron bands have relatively low ductility; elongation of the present ones is below 5%, as compared to around 40% for gilding metal. However, by proper band design and methods for seating the bands, their ductility has been found to be adequate. Sintered iron bands are designed so that the axial dimension (*i.e.,* width or height of the band) is only slightly larger than the mouth of the band seat. This reduces to a minimum the amount of plastic flow that is required for proper seating. Conventional hydraulic swaging methods used for seating copper bands are employed for sintered iron bands. Tapered die seating methods are also very satisfactory. The load must be uniformly applied all around the porous band to minimize the possibility of cracking.

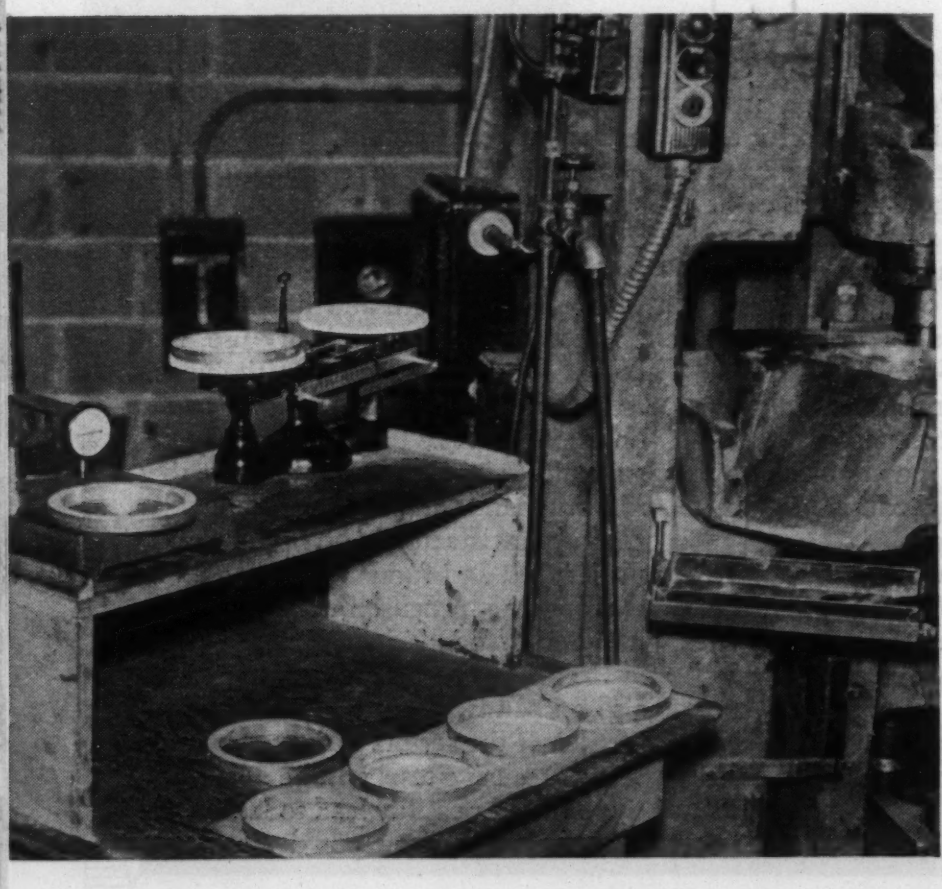
Sintered iron band blanks in present use have a tensile strength of 12,000 to 18,000 psi, as compared to 35,000 to 40,000 psi for conventional gilding metal band blanks. However, ballistic tests have shown that this order of tensile strength is adequate in present applications to prevent shearing off of the band in the gun barrel or loss of the band during flight of the projectile. The bands produced by the Germans were generally of lower tensile strength, ranging from 10,000 to 12,000 psi. However, on some 20- to 30-mm bands, the tensile strengths were as high as 25,000 and 30,000 psi (as-sized). Low strength material was at least partially the cause of many of the German bands breaking off in flight during early development.

Design of the band seat also helps significantly in holding the band in place during projectile flight. The slot into which the band is seated is undercut so that when properly fitted the band is effectively keyed in.

Besides having adequate strength and ductility for the application, the porous nature of sintered iron contributes some other desirable characteristics to rotating bands. In certain instances higher pressures in the gun barrel can be obtained with sintered iron bands, because they are more effectively engraved by the rifling and provide a good gas seal. Copper bands, in passing through the gun barrel, sometimes undergo partial melting, causing gas leakage. Also, their dense structure makes it necessary to provide circumferential grooves to take care of some of the metal displaced by the engraving action. However, a sintered iron band, in effect, can deform within itself, because of its porous structure. Thus, during engraving the density of the band increases. A large percentage of the voids are filled

Steps in producing and applying iron powder rotating bands.

(1) *At extreme right a band is shown in press; finished bands also shown. (Photos 1, 2 and 3 courtesy Powdered Metal Products Corp.)*



(2) *After pressing, bands are sintered in atmosphere furnace.*

with paraffin, however, and this influences to some extent the engraving action.

Reports on the German work indicate that higher muzzle velocities can also be expected with sintered iron powder bands. In addition, sintered iron bands do not form thick deposits of band material within the gun barrel, which in the case of gilding bands causes loss of accuracy.

Up until now, very limited data have been obtained in this country on gun tube wear produced by porous iron bands as compared to gilding metal bands. Reports on the German work give varying opinions. The Germans succeeded in achieving a useful gun life for normal and low velocity weapons. Greater wear was probably encountered in high velocity applications. Due to the tremendous expansion of the iron powder and band fabricating industries in a relatively short period of time, under wartime conditions, many sintered bands of inferior quality and mechanical properties were of necessity employed in German shell production.

Production of Domestic Bands

Starting about 1942, Watertown Arsenal Laboratory, which has the only powder metallurgy facilities in the Ordnance Corps, fabricated all of the initial experimental sintered iron bands that were employed on projectiles up to 90 mm in caliber. Later, Merriman Bros., Inc., under specifications provided, fabricated band lots that were too large for the Arsenal laboratory facilities. This company also manufactured some large caliber bands that required a high tonnage hydraulic press and large sintering furnace equipment. To date, over 25,000 sintered iron bands have been prepared for ballistic and laboratory tests. General industry is now assisting in the manufacture of porous iron bands for the Ordnance Corps programs.

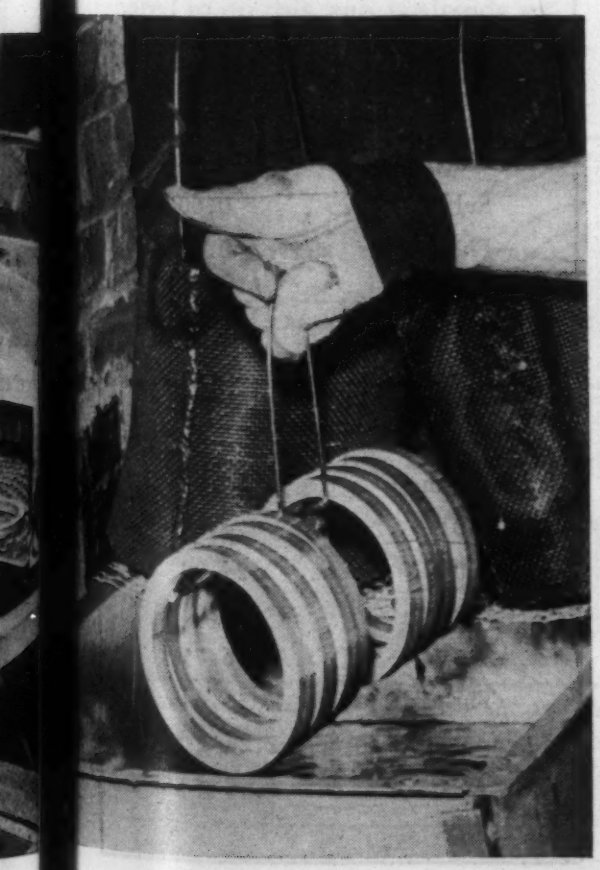
Conventional powder metallurgy methods are used to produce domestic sintered iron bands. The powder is compacted in a die at pressures of about 30 to 50 tons per sq in. Automatic mechanical presses are used for pressing bands up to 90 mm in caliber, and semi-automatic hydraulic presses have been employed for larger caliber bands.

As with any sintered powder metal component, the height (or width) of sintered iron bands, which is the dimension in the direction of pressing, is important because of the problem of achieving uniform density throughout the compact. If the ratio of band height to wall thickness is too great, the center portion of the band is likely to be weak. Sintered iron bands for high velocity projectiles have a wall thickness of ¼ to ½ in., depending on the caliber, and are about ½ in. high. These dimensions are appropriate for powder metallurgy techniques. The ratio of height to wall thickness for gilding bands runs as high as 8 to 1. This is an impracticable ratio for sintered iron bands and, in such cases, two or more bands must be employed.

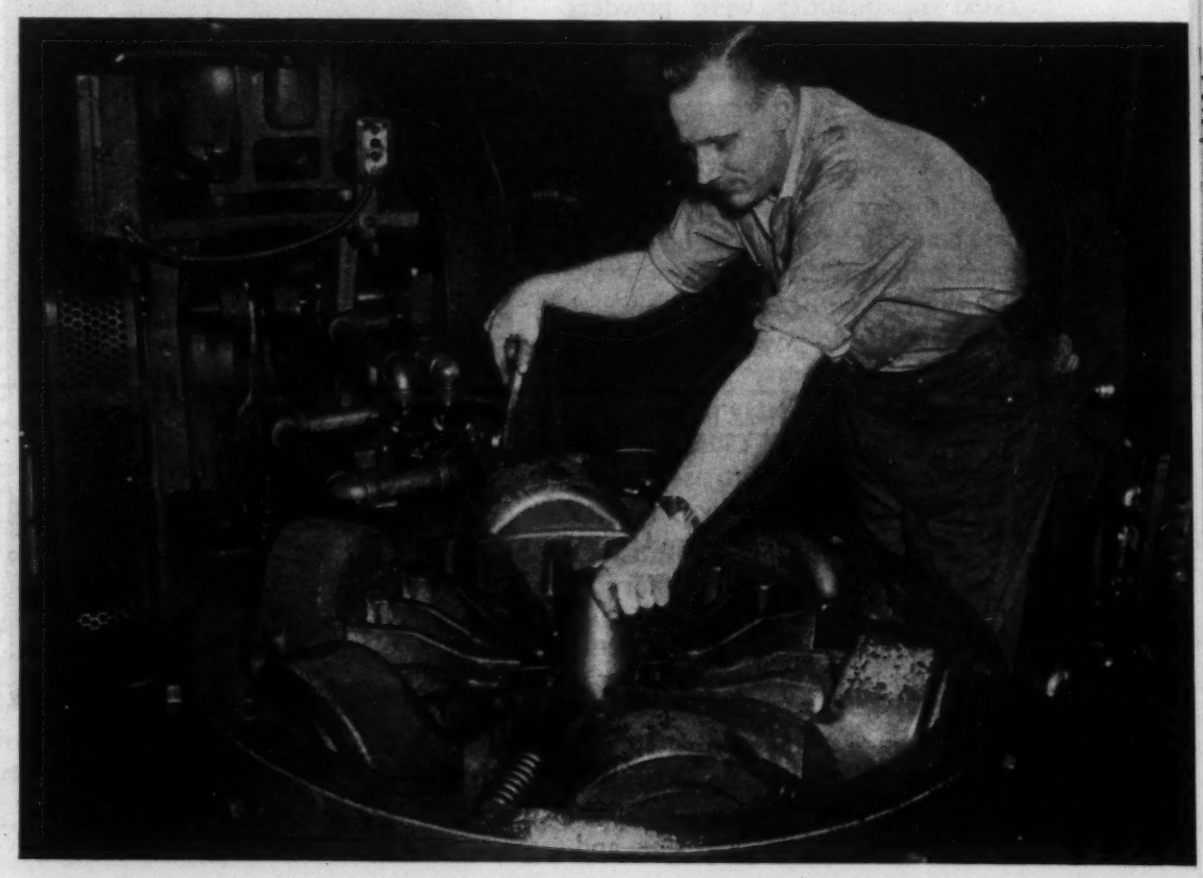
Bands after pressing have been sintered in hydrogen or cracked city gas atmospheres for about 1 hr at 2012 F. The density of the bands after sintering ranges from 5.5 to 5.8 g per cc. After sintering, the bands are impregnated with paraffin to prevent internal corrosion. Many other types of impregnants, including lead, sulfur, lead oxide and zinc oxide, have been suggested. Tests are now being conducted to evaluate the effect of impregnants on gun wear.

No coining or sizing of the sintered iron band is normally needed. The

(3) *Sintered bands are impregnated by dipping in tank of paraffin.*



(4) *Bands can be pressed on projectiles by means of this hydraulic machine. (Courtesy Frankfort Arsenal)*



Germans, however, sometimes sized the internal diameter with a mandrel. On the other hand, when the band is swaged on the projectile, minor warpage and eccentricities are corrected. The density of the band increases about 0.4 g per cc during the seating operation. After the band is seated it is machined to final dimensions. Single point carbide tools are in present use, but form tools will probably prove feasible.

Iron Powders for Rotating Bands

It is believed that practically all of the iron powders of minus 100 mesh sieve analysis that are in widespread commercial use are suitable for rotating bands for low velocity weapons. A hydrogen reduced mill scale powder, which is of higher strength and cost than many iron powders, was used in the development tests of bands for high velocity projectiles. The composition, sieve analysis and properties of this powder are given in the accompanying table. Tests are now under way on other types of domestic iron powders and on Swedish powders.

The Germans used relatively soft iron powders, low in carbon (0.10% or less) and silicon (0.025%). The most widely used powder was the type produced by the Hametag process. In this process, scrap metal in the form of chips, borings, turnings, wire, etc. are pulverized in a beater or hammer mill by being whirled against one another. The resulting particles have a disk or plate shape and the powder has good compressibility.

Next in quantity were powders made by the D.P.G. process. In this method, a stream of molten iron is passed through a layer of injected water. The resulting small particles are further crushed into finer particles when thrust on to a rapidly rotating disk. The particles thus produced have a rough spherical shape.

Small amounts of sponge iron and reduced mill scale powders were also used by the Germans.

While 100% Hametag powder was preferred, the demand caused a scarcity and it was necessary to use various mixtures. One of the most popular was a mixture of 70% Hametag and 30% D.P.G. powders. Another was a 50-50% mixture of these powders. An accompanying table gives the composition and sieve analysis of a 70% Hametag-30% D.P.G. mixture used for the German bands shown in the figure. These bands have a tensile strength of 11,000 to 12,000 psi (as-sized), a density of 5.9 g per cc, and are impregnated with paraffin, 2.5 to 3.0% (by weight).

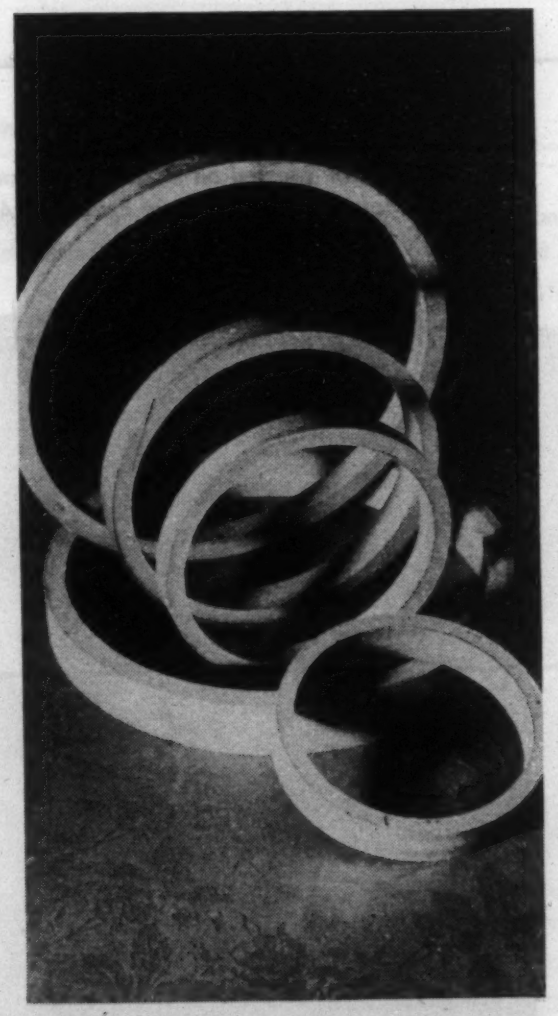
Expansion of Iron Powder Facilities

The question naturally asked is, whether our iron powder production and fabricating facilities are adequate to take care of a program involving millions of sintered iron bands. The answer is that present capacity is not nearly adequate, but we could expand sufficiently to handle the increase.

There are too many uncertain factors involved at this time to give an accurate estimate of how much iron powder would be required if sintered iron powder bands were to be used on a large scale. However, the prevailing view in military circles is that the use of copper for rotating bands should be avoided wherever possible. Although plastics and other wrought materials are also potential substitutes and may prove to be superior to porous iron for certain specific applications, the use of sintered iron is in the most advanced state, and, consequently, it will undoubtedly be used in substantially greater quantities during the next few years. One estimate is that if sintered iron powder bands were used on all projectiles, about five million lb of powder per month would be required.

At present our total domestic iron powder production is only 600,000 to 800,000 lb per month. Not all of this powder, however, would be suitable for rotating bands from a cost standpoint. Electrolytic iron powder, for example, at its present price would probably be too costly. In addition to domestic production, Swedish iron powder imports average about one million lb per month. Therefore, to achieve a production of five million lb per month, an expansion in iron powder output of over three million lb per month would be required. One metal powder producer indicates that an expansion of this order would take a minimum period of one year using present available methods. Some feel that this is a somewhat optimistic estimate.

It must be remembered that the above figures do not take into account the continuing and rapidly expanding use of iron powders in new and established applications or the possible loss of Swedish iron powder imports. Considering these, our present iron powder production capacity would have to be expanded to at



A group of various size German iron powder rotating bands. Bands ranged from 20 to 210 mm. (Courtesy American Electro Metal Corp.)

Characteristics of Iron Powder Used in Ordnance Corps Development Work (Hydrogen Reduced Mill Scale)

Composition, % by Weight	
Carbon	0.045
Manganese	0.38
Silicon	0.065
Sulfur	0.006
Phosphorus	0.005
Oxygen	1.48
Total Iron	98.06
Particle Size Analysis, % Retained by Weight	
100 mesh	0.02
140	4.12
200	24.90
270	18.04
325	16.75
Through 325	35.64
Apparent Density	2.24 g per cc
Flow Test	1.66 g per sec

Composition and Particle Size Distribution of Typical German Iron Powders

	Hametag	D.P.G.
Composition, %		
Carbon	0.03-0.07	1.7*
Oxygen	0.20	2.5
Sieve Analysis, % by Weight		
+ 40 mesh	4.8	1-3
− 40 + 50	11.3	2-4
− 50 + 100	35.7	20-30
− 100 + 230	39.2	35-55
All Through 230	8.0	15-25

** Reduced prior to use, resulting in carbon content below 0.1%.*

least eight or ten million lb per month, which is over ten times present capacity. And in the event of an all-out war, iron powder production capacity would have to be expanded many more times.

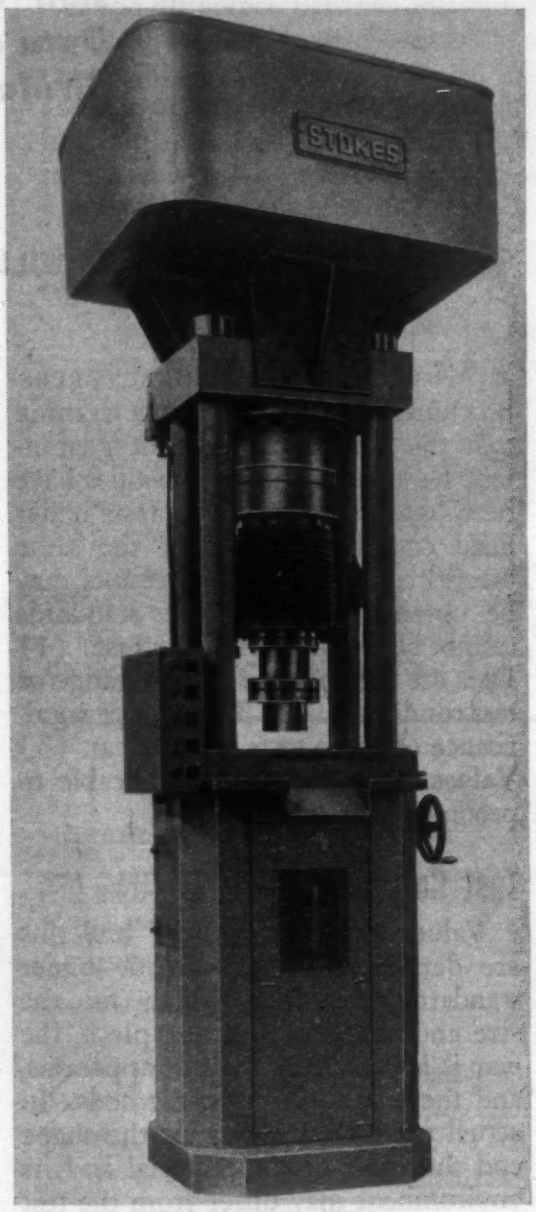
Under present conditions it is unlikely that the government will subsidize the iron powder industry to obtain greater output. Thus, the ultimate extent to which sintered iron rotating bands are adopted will depend largely upon the capacity of the iron powder industry to expand its facilities in pace with military demands.

From all indications, the industry is prepared to do this, and is already expanding. All iron powder producers are increasing production to their present available capacity, and at least four companies are planning considerable expansion of facilities. Also, a new plant to produce iron powder of the Swedish sponge iron type is under construction. In addition, moves are in progress to bring into this country both the Hametag and D.P.G. processes, which were used extensively during the last war in Germany. Based on the German experience, powders made by these methods would probably be satisfactory for rotating bands, and be of a price competitive with present domestic powders.

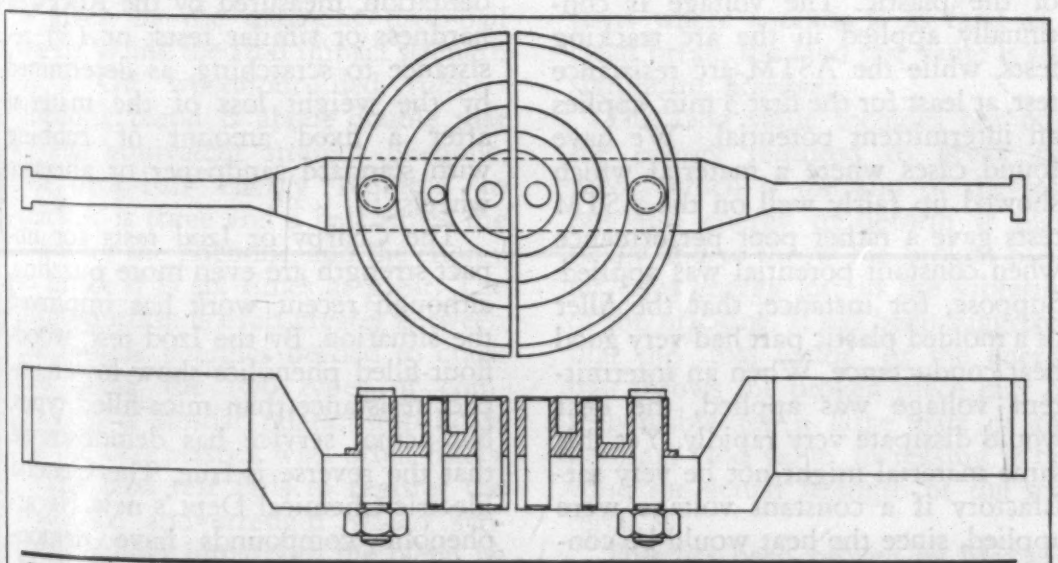
The large scale use of iron powder rotating bands would also, of course, require an expansion of powder metallurgy fabricating facilities. Although there undoubtedly would be many problems, the industry in general believes they can expand to meet the demand.

The bands for shells up to and including 90 mm can be made on fast acting mechanical presses. Presses of this type are already in use on a wide variety of metal powder parts in a number of fabricating plants. For mass producing 120 mm projectiles and larger, automatic, fast acting hydraulic presses will be required. One of the largest manufacturers of metal powder presses reports that several presses of this type have been built for uses other than metal powder parts fabrication. These presses, however, can be readily adapted to shell band work. They range in size from 200 to 500 tons capacity, and will produce up to 15 bands per min. The company reports that on 4 to 5 months notice they could manufacture four presses a month.

All in all, it looks as though the rotating band program will give the powder metallurgy industry a tremendous boost. However, it may be only a temporary one, as was the case during the last war. What will be done with all the powder metallurgy facilities come normal times is a serious problem that the industry must face. It can only be solved by intensive market development work by all segments of the field to find and develop new uses for metal powder parts.



For mass producing 120-mm bands and larger, automatic hydraulic presses, such as the 200-ton capacity one shown here, will be used. (Courtesy F. J. Stokes Machine Co.)



Germans conducted acceptance tests on rotating bands themselves rather than on test bars, which do not necessarily give representative results. This special test fixture can be used for three different size bands. (Courtesy American Electro Metal Corp.)

Acknowledgments

American Electro Metal Corp.
Merriman Bros., Inc.
Plastic Metals Div., National Radiator Co.
Powdered Metal Products Corp. of America
F. J. Stokes Machine Co.
Watertown Arsenal, Army Ordnance Corps

How to Interpret Property Values of Plastics

Conventional test results are sometimes unreliable guides in the design of molded plastic products. Data obtained by new tests and individual test models are aids to sound design.

by **WILLIAM SCHACK***

● MOST PLASTICS MANUFACTURERS' brochures are prefaced with a warning that the data given are not guaranteed because the property values have been obtained by standard tests under fixed conditions. Without the same careful controls, different results may be obtained. At best, the standards cannot be taken literally because: (1) Data are limited to a narrow range of test conditions. (2) The precise significance of some tests is not clear. (3) Values are not directly applicable to products of varying design.

Test Conditions

Values in manufacturers' bulletins are derived from tests made under standard conditions which fix the size and shape of the test piece, the way it is produced, the test apparatus, and the test application methods. In actual product applications the shape and thickness of the material and its environment may differ from the test conditions.

While standard values for modulus of elasticity, yield stress, tensile strength and other tensile properties are suggestive for research, engineering design, quality control and material acceptance specifications, they "cannot be considered significant for applications differing widely from the load-time scale of the standard test. Such applications require suitable tests, such as impact, creep and fatigue."[1]

The Plastics Technical Service Laboratories of the Dow Chemical Co. found that creep reduces the allowable working stress of polystyrene well below the value indicated by its tensile strength measured by the ASTM method. A continuous load caused failure of an injection molded bar in less than 1000 hr at 60% of the ultimate tensile stress measured by ASTM D638–49T. The same specimen failed in 40 min at 80% of the ultimate tensile strength.

Dielectric strength values are usually based on tests made under oil. The Navy found that values for silicone laminates that were derived in air were 70% below manufacturers' standards based on tests in oil. For the silicone laminates in question, the disparity was critical since the material was actually going to be used in air.

W. H. Edmunds,[2] of the I.T.E. Circuit Breaker Co., Philadelphia, notes that standard arc resistance data are of less significance for some applications than the arc tracking properties of the plastic. The voltage is continually applied in the arc tracking tests, while the ASTM arc resistance test, at least for the first 3 min, applies an intermittent potential. "We have found cases where a material which showed up fairly well on the ASTM tests gave a rather poor performance when constant potential was applied. Suppose, for instance, that the filler of a molded plastic part had very good heat conductance. When an intermittent voltage was applied, the heat would dissipate very rapidly. Yet this same material might not be very satisfactory if a constant voltage were applied, since the heat would be continuously concentrated at the surface. In addition, the arc tracking test more nearly approximates the dielectric test which is given to the circuit breaker, in our case, than does the arc resistance test with its intermittent applied voltage."

When a component is molded by a different method than the test specimen, and has a different shape, significant departures from the standard test property values are to be expected. A Hamilton Standard phenolic propeller brush block was much thicker than the standard test specimen and was transfer rather than compression molded. The additional thickness probably prevented uniform heating in the molding process. These variations from test conditions caused a marked reduction in tensile and flexural strength, impact resistance, specific gravity, and water absorption from the manufacturer's values.

Even under experimental conditions, standard property values for plastics are valid only within a narrow range of environmental conditions. Some properties are affected by temperature variations; the standard dielectric strength is not a very useful guide in choosing a phenolic to be used in an electrical application in which it will gradually heat up. The step-by-step dielectric strengths in volts per mil for a typical range of general-purpose, electrical and heat resistant grades are 63–375 at 77 F against 40–60 at 212 F; 250–400 against 100–150; and 125–325 against 40–60.

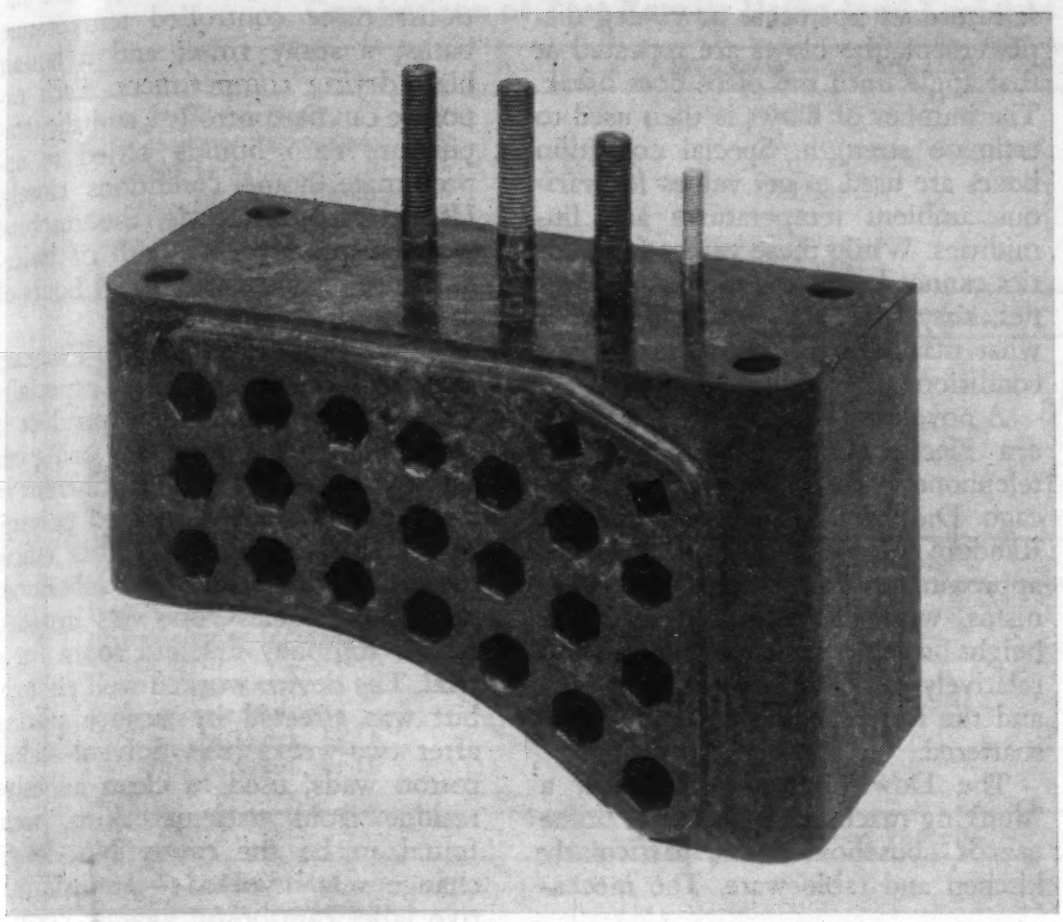
Significance of Tests

The actual meaning of some test values for plastics is not clear, even though the data have been obtained by precise methods. The term abrasion resistance may refer to: (1) resistance to cutting, for which there is a standard test; (2) resistance to indentation, measured by the Rockwell hardness or similar tests; or (3) resistance to scratching, as determined by the weight loss of the material after a fixed amount of rubbing with standard sandpaper or abrasive wheels.

The Charpy or Izod tests for impact strength are even more puzzling, although recent work has improved the situation. By the Izod test, wood-flour-filled phenolics show lower impact resistance than mica-filled types, but actual service has demonstrated that the reverse is true. The General Electric Chemical Dept.'s new Hycar-phenolic compounds have demonstrated in actual usage a strength advantage over comparable phenolics that is much greater than the Izod differential.

A true service evaluation, however,

* *Editor, "A Manual of Plastics and Resins, in Encyclopedia Form"*



A phenolic propeller brush block is thicker than the standard test piece and is transfer rather than compression molded. Significant differences in properties result as seen in table below. (Courtesy Hamilton Standard Div., United Aircraft Corp.)

How Plastics Data Can Vary

Property	Material Manufacturer's Catalog Data	Product Manufacturer's Test Data
Ten Str	6,500 psi min	2,580 psi
Compressive Str	20,000 psi min	31,650 psi
Flexural Str	9,000 psi min	6,300 psi
Izod Impact Str	1.0 ft-lb min	0.983 ft-lb
Specific Gravity	1.37-1.41	1.33
Water Absorption	0.9% max	0.62%

is given by the magnetic drop-ball tester. While the Izod impact strength of a GE woodflour-filled rubber-phenolic blend is about double that of the equivalent straight phenolic, the drop-ball energy required to crack it is three and a half times the value for the phenolic, and the energy to break it is six times as great. The disproportion is even greater between the fatigue energies needed to crack and break the two types of compounds. A similar relationship holds for the two plastics with other fillers.

The Izod test fails to register the resilience and strength which synthetic rubber imparts to the blend by increasing the modulus of elasticity. The drop-ball test, on the other hand, gives an index of the differential between energy-to-crack and energy-to-break which provides an additional practical factor of safety. For applications where a crack is as fatal as a clean break, the Izod test value is still significant, however.

The Izod value includes not only the energy required to break the piece, which is the aim of the test, but also energy to deform it plastically and to throw the broken piece off, plus energy lost in the vibration of the machine. It has been suggested that the "toss factor" or the energy that throws the broken piece may be responsible for a large part of the nominal Izod value, increasing it beyond the actual strength of the material.

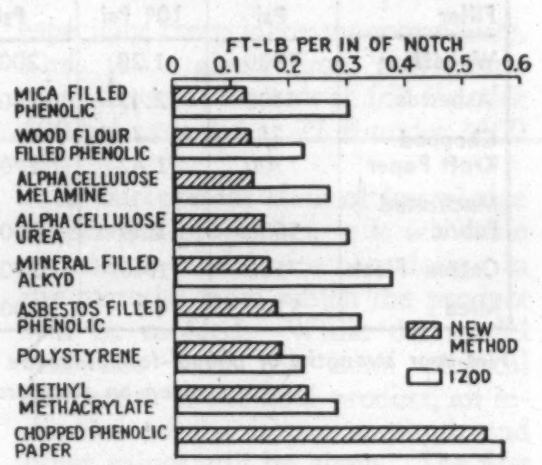
This has been proven by Maxwell and Rahm at Princeton, working with a new apparatus in which the specimen is placed on the edge of a flywheel and its projecting edge broken against a stationary anvil as the wheel turns. The impact is computed from the flywheel's change of speed as the break occurs. It can be mathematically proven that the energy in the broken specimen equals the energy in the specimen prior to the impact; in other words, the toss factor is eliminated. As a result, this machine gives lower impact values than the Izod test.

The values obtained by the new apparatus are closer to service experience than Izod figures. For some plastics, the difference between the values obtained on the two machines is more than 100%. The variations in the amount of the toss factor among different plastics are due to differences in their specific gravities, since a lighter material absorbs less energy.

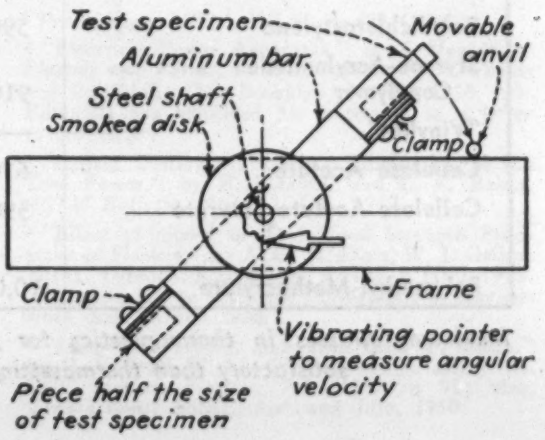
Applying Test Values

End products themselves should be submitted to tests approximating service conditions if there is any doubt of the applicability of standard data or if there are no standard procedures to test performance under certain application conditions.

Laboratory figures indicate that polystyrene is impractical for dollhouse furniture, yet the material actually stands the wear and tear of chil-



Test apparatus (below) used by Maxwell and Rahm at Princeton eliminates the toss factor from impact values given by the Izod machine. Results obtained correlate more closely with actual usage (above).



dren's play quite well, as enormous sales in the last few years indicate.

The use of polystyrene wall tiles grew so rapidly that the National Bureau of Standards developed a commercial specification for them and their mastics. Most of the standard tests were found to be inapplicable. Even the impact strength could not be successfully measured because of the failure of the Izod test to take the effect of the mastic into account. Tile specifications finally included the sun lamp color stability test and the ASTM raw material specification. The heart of the specifications, however, is a simple heat distortion test which, as E. E. Ziegler of the Dow Chemical Co. points out, is closely related to actual service conditions and can be carried out by untrained people with simple equipment.

The United States Testing Co. devised a drop-weight apparatus to avoid the uncertainties of standard impact tests. A round-nosed, 5-lb pendulum bob is swung against a fixed specimen starting from increasing pendulum displacement angles. If failure does not occur at 90-deg displacement, the blows are repeated at that angle until the piece does break. The number of blows is then used to estimate strength. Special condition boxes are used to get values for various ambient temperatures and humidities. While these values for plastics cannot be related to standard values, they give an empirical idea of what may be expected under service conditions.

A novel test was used by the Western Electric Co. on cellulosic desk telephone parts molded by the Chicago Die Mold Manufacturing Co. Random samples, with dummy loads approximating the operating mechanisms, were dropped from a 30-in. height on a corner that was considered relatively weak. The height was varied and the test repeated until the piece shattered.

The Dow Chemical Co. built a "dunking machine" to simulate home use of household items, particularly kitchen and table ware. The mechanism cycles samples through five stations: three controlled temperature baths; a spray rinse; and a hot-air blast drying compartment. Each exposure can be controlled, and the temperature bath liquids varied to approximate home conditions closely. Using a 20-min cycle, the machine would reproduce a month of twice-daily use of houseware in 24 hours of operation.

Dow's Product Evaluation Program also includes field tests, especially where the durability of a product is questioned. These tests may bring out service faults that are not inherent in the product itself. A molded polystyrene tape dispenser for doctors' offices seemed satisfactory in laboratory tests. Nevertheless, one was installed in the company first aid room for a trial. The device worked well enough, but was effected by surface pitting after two-weeks' use. Solvent-soaked cotton wads, used to clean adhesive residue from patients' skins, were found to be the cause. No design change was involved — an informative label cautioning against contact with the destructive solvents was merely added. The discovery of a possible user abuse was as important as spotting a mechanical defect.

The Dow tests are designed to be severe for three reasons: (1) to provide a safety factor for abuse; (2) to indicate in a short time the results of several months normal usage; and (3) to anticipate harsher treatment in storage and shipment than the product may receive in actual use.

Strength Properties of Phenol-Formaldehyde Materials

Filler	77 F			167 F			
	Ten Str Psi	Ten Mod 10^6 Psi	5-yr Str Psi	Ten Str Psi	Ten Mod 10^6 Psi	5-yr Str Psi	Notch Sensitivity
Woodflour	7800	1.28	2000	8000	1.30	1200	2.0
Asbestos	4400	2.47	1500	4800	2.3	——	1.7
Chopped Kraft Paper	7700	1.42	2700	6500	1.39	1200	1.3
Macerated Fabric	5600	1.49	2000	5600	1.45	1200	1.0
Cotton Flock	7500	1.40	2700	6100	1.48	1200	1.4
Mica	5700	4.5	2000	6000	——	——	1.3

Five-year strengths of phenol-formaldehyde materials are much lower than tensile strengths given on standard, short-interval tests.

Strength Properties of Thermoplastics

Material	77 F				167 F
	Ten Str	Ten Mod	Strain to Failure	1-Yr Str	1-Yr Str
Polystyrene	7500	0.48	2.1	800	250
Polymonochlorostyrene	9500	0.52	2.5	1200	400
Polydichlorostyrene	5900	0.60	1.0	1500	400
Styrene-Acrylonitrile Copolymer	9100	0.43	2.2	1500	560
"Vinylite"	——	——	——	1600	——
Cellulose Acetate	6700	0.35	5.5	600	——
Cellulose Acetate-Butyrate	3900	0.16	9.5	Less than 600	——
Polymethyl-Methacrylate	10,000	0.43	4.2	2000	——

Maximum stresses in thermoplastics for one year show that thermoplastics are less satisfactory than thermosetting plastics under persistent stress.

Broadening Tests

A beginning has been made in broadening test conditions and in measuring the effect of various modifying factors. Standards will never cover every situation, but sufficient data will minimize the necessity for special tests by individual end users of plastics.

The tensile strength of polymethyl methacrylate varies from 5500 to 7000 psi as the rate of straining increases from 0.050 to 0.400 in. per min at 104 F. For one acetate formulation, the yield point and fracture stress have been shown to increase with increasing strain rate in tension, compression and torsion; the modulus of elasticity in tension and torsion was independent of strain rate and the modulus of compression increased with increasing rate of strain.

As part of the program of fundamental research into the mechanical properties of plastics sponsored by the Plastic Materials Manufacturers

Comparison of Test Results Using Izod Test and Drop-Ball Test

	Woodflour-Filled Phenolic	Woodflour Rubber-Phenolic
Izod, Ft-Lb/In. Notch	0.3	0.60
Drop Hammer Increasing		
Height to Crack, Ft-Lb	0.924	3.330
to Break, Ft-Lb	1.508	9.480
Drop Hammer Fatigue Energy		
to Crack, Ft-Lb	0.714	4.800
to Break, Ft-Lb	3.340	37.935
	Cotton-Flock-Filled Phenolic	**Flock Rubber-Phenolic**
Izod, Ft-Lb/In. Notch	0.66	1.00
Drop Hammer Increasing		
Height to Crack, Ft-Lb	1.621	4.129
to Break, Ft-Lb	5.540	14.340
Drop Hammer Fatigue		
to Crack, Ft-Lb	0.521	13.050
to Break, Ft-Lb	7.650	51.610
	Fabric-Filled Phenolic	**Rubber-Phenolic Fabric**
Izod, Ft-Lb/In. Notch	1.30	2.30
Drop Hammer Increasing		
Height to Crack, Ft-Lb	3.155	10.290
to Break, Ft-Lb	10.030	33.930
Drop Hammer Fatigue		
to Crack, Ft-Lb	1.767	13.856
to Break, Ft-Lb	15.546	84.210 (Not completely destroyed)
	Asbestos Fiber-Filled Phenolic	**Asbestos Rubber-Phenolic**
Izod, Ft-Lb/In. Notch	0.34	0.40
Drop Hammer Increasing		
Height to Crack, Ft-Lb	0.421	3.140
to Break, Ft-Lb	0.421	6.500
Drop Hammer Fatigue		
to Crack, Ft-Lb	0.480	0.997
to Break, Ft-Lb	0.480	7.900

Assn. (now incorporated in the Manufacturing Chemists' Assn.), workers at the Massachusetts Institute of Technology have made a study of the effect of speed of test on the strength properties.[4] Using three formulations of cellulose acetate butyrate, two grades of paper-base laminates and a fabric-base laminate, they found that flexural maximum stresses are substantially linear functions of the logarithm of the rate of load and that maximum compressive stresses are similar functions of the rate of crosshead motion.

An intensive study of long-time creep and tensile tests was undertaken recently.[5] These factors must be taken into account in fan blades resisting centrifugal stresses, material around metal inserts under stresses from differential contraction, parts under direct load, pieces subjected to stress due to differential water absorption, and moldings which shrink in a high ambient temperature. Creep tests are also thought to be related to fundamental physical properties, and they are, of course, essential in designing plastics for light structural uses.

In this study, thermosetting and thermoplastic materials were subjected to constant load at 77 and 167 F for periods ranging from 1000 to 14,500 hr. Electric strain gages measured creep, giving an estimate of the maximum stresses which thermosetting materials could sustain for five years. The figures for phenol-formaldehyde were much lower than the tensile strengths found by the standard tests for short intervals. At room temperature, a general-purpose compound (woodflour-filled) was about 25% as strong after five years; at 167 F it was 15% as strong. These figures are valid only for unnotched specimens. They must be divided by a notch sensitivity factor if a sharp indentation is present.

Maximum stresses in thermoplastics, governed by both creep and crazing, were computed for one year. The results indicate that for all their higher tensile strengths, thermoplastics are less satisfactory than thermosetting materials under persistent stress. Their heat distortion temperatures, ranging from polystyrene's 181 F to polydichlorostyrene's 227 F, are not a reliable guide to serviceability at 167 F.

While the data for thermoplastics were not comprehensive enough to allow stress to be correlated with creep, there were indications that deformation increases out of proportion to stress. At elevated temperatures especially, creep increases enormously. Thus, in a given time, polystyrene crept the same amount at 167 F under 400 psi as it did at 77 F under 3600 psi.

In our present state of knowledge of plastics properties, it is advisable to make a model of a new design in the material from which the product will be molded. While the model will not have the same physical properties as the final product, an indication of the impact strength and other values will be given. The first samples should also be tested under use conditions. The mold can then be modified to strengthen points of probable failure.

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[2] "Electrical Power Apparatus," in *A Manual of Plastics and Resins, in Encyclopedia Form*, Chemical Publishing Co., Brooklyn, N. Y., 1950. Mr. Edmunds has amplified his statement in a letter to the writer.

[3] "Impact Testing of Plastics: Elimination of the Toss Factor," by B. Maxwell and L. F. Rahm, *ASTM Bulletin*, No. 161, Oct. 1949.

[4] "Effect of Speed of Test Upon Strength Properties of Plastics," by A. G. H. Dietz, W. J. Gailus, and S. Yurenka. Proceedings, ASTM, p 1160, 1948. This paper has an extensive bibliography of previous work done in this field.

[5] "Long-Time Tension and Creep Tests of Plastics," by C. E. Staff, H. M. Quackenbos, Jr. and J. M. Hill, *Modern Plastics*, Feb. 1950, p 93; also, *Transactions*, ASME, Apr. and July, 1950.

Pearlitic Malleable Irons Can Be Successfully Surface Hardened

When a hard, wear resistant surface, produced by flame or induction hardening, is added to the other desirable properties of pearlitic malleable castings, the number of possible applications is greatly increased.

by S. H. BUSH, F. B. ROTE and W. P. WOOD, University of Michigan

● PEARLITIC MALLEABLE IRON castings with their easy machinability, good ductility, high shock resistance and low cost of manufacture have many and diverse applications in industry. Properly heat treated, they combine the strength of forgings with the adaptability of castings, particularly in thin sections or in intricate shapes. By adding to these properties a hard, wear resisting surface, such as can be obtained by flame or induction hardening, the number of possible applications for pearlitic malleable castings is greatly increased.

Proper methods and control of variables produce cases averaging 60 to 62 Rockwell C on the surface and depths of case capable of variations from as low as 0.050 in. to any desired depth, with no loss in uniformity of hardening. Proper control also eliminates danger of spalling, decarburization, sweating, or excessive porosity due to loss of temper carbon.

Surface hardened pearlitic malleable irons have many possible applications, some of which are now in use, others which are still potential. Typical examples of applications (existing and potential) in the automotive and other industries are: engine valve rocker arms, rocker arm shafts, transmission shifter forks, fuel pump liners, cam shafts, engine cylinder liners, wheel hubs, external and internal gears, cams, sprockets, refrigerator crank shafts, rifle receivers, rolls, pneumatic tool cylinders, forming dies, lathe beds, armor plate, C-clamps, and micrometer frames.

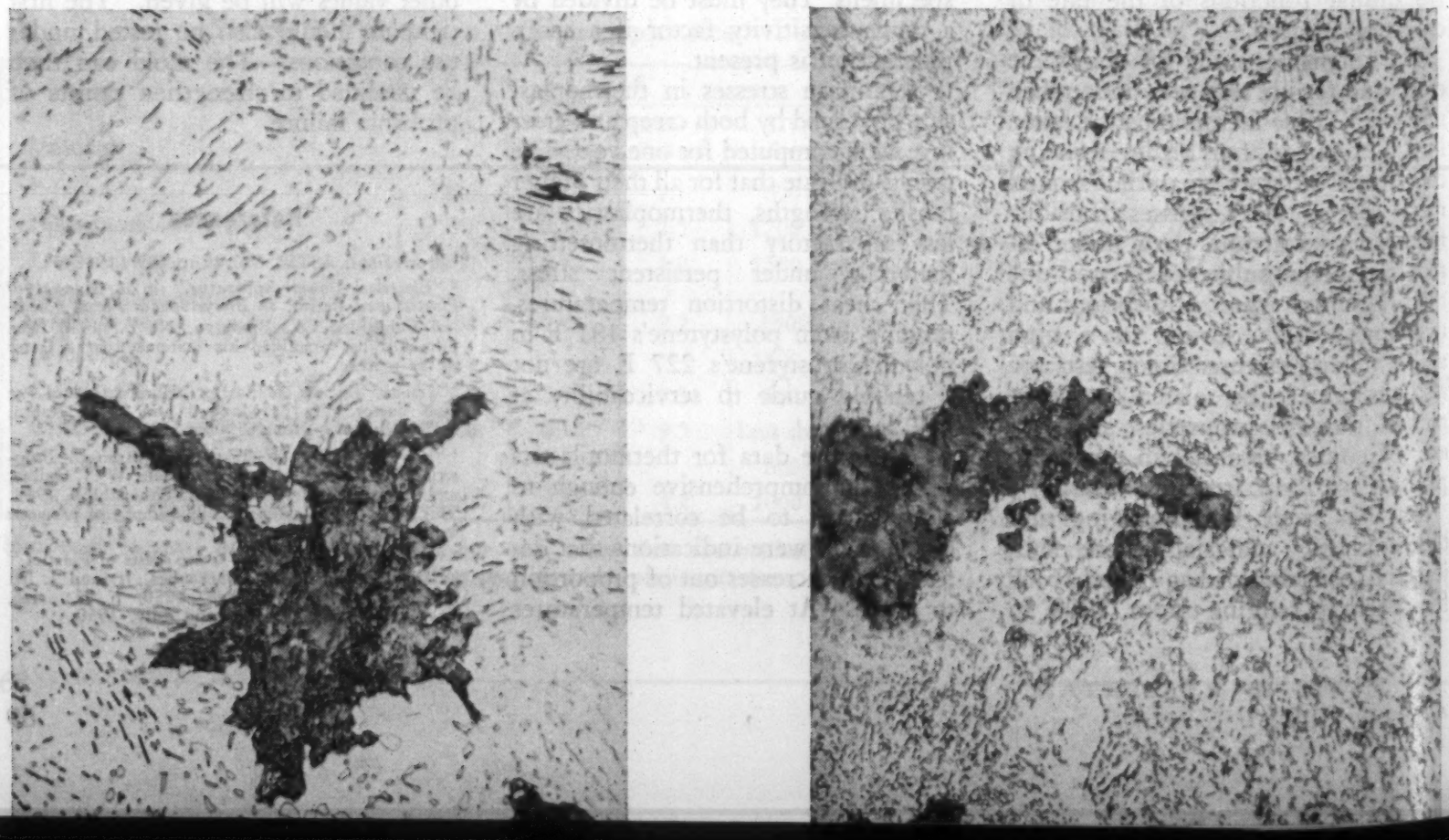
Proper Microstructure Important

One of the most important variables to consider in surface hardening pearlitic malleable iron is microstructure of the piece. However, this is often ignored while other items are carefully considered. This is obviously bad practice, since a change from a poor to a good microstructure can easily reduce by half the heating time on a thin case, resulting in a saving in time and in power.

Results of a series of experiments on nine commercial pearlitic malleable irons conducted at the University of Michigan under the auspices of the Research Committee of the Malleable Div. of the American Foundrymens' Society verified the fact that the most important variable is the matrix microstructure of the iron. It was found that chemical composition and graphite size, shape and distribution were secondary factors.

The most satisfactory microstruc-

Fig 1—Microstructure is of paramount importance in surface hardening pearlitic malleable irons. At right is the most satisfactory structure, having a matrix of finely spheroidized cementite. The matrix, at left, is much coarser and is the least satisfactory. (100X)



ture proved to be one made up of finely spheroidized cementite, such as is shown in Fig 1, right. The least satisfactory consisted of a structure of coarsely spheroidized cementite similar to that shown at left. Fig 2 shows the pronounced difference in graphite size, shape and distribution which the tests showed had no apparent effect on the hardening properties of the irons.

Two Methods Used

The two possible methods of surface hardening commercial pearlitic malleable irons are flame and induction hardening. Some objects, due to their shape, can be more satisfactorily treated by flame hardening; others can best be hardened in an induction unit. The size and shape of the casting, area to be hardened, depth of case desired, and method of quenching control, to a great extent, the selection of the hardening technique.

Flame Hardening—In flame hardening, oxyacetylene, oxygen-natural gas, or air-natural gas are used with stationary, spinning, progressive or combination hardening techniques. When using oxyacetylene, in particular, adequate control of surface temperature and length of heating cycle is essential. Too high a surface temperature results in severe sweating, resulting in a non-uniform layer of white iron on the surface. Too low a temperature gives a non-uniform case of pearlite and martensite with inadequate resistance to wear.

Tests made to determine the optimum indicated surface temperature and quenching medium for obtaining a case with a hardness of Rockwell 50 C at a minimum depth of 0.060 in. showed that a temperature of 1500 F and an agitated water quench yielded best results.

The curves shown in Fig 3 indicate the hardness and depth of case of some typical commercial pearlitic malleable irons which have been flame hardened at 1500 F and water quenched. The curve Y represents an iron having a matrix of finely spheroidized cementite.

Small gears, hubs, housings and plates are typical products hardened with flame heating equipment.

Induction Hardening—By proper selection of power input and heating time, as well as proper coil design, it is possible to satisfactorily surface harden most pearlitic malleable irons. Experiments conducted using nine commercial irons differing in chemical composition, microstructure, graphite size and distribution, and melting and malleabilizing practice, indicated that all irons could be induction hardened satisfactorily, but some were much more responsive than others.

As in flame hardening, it is possible

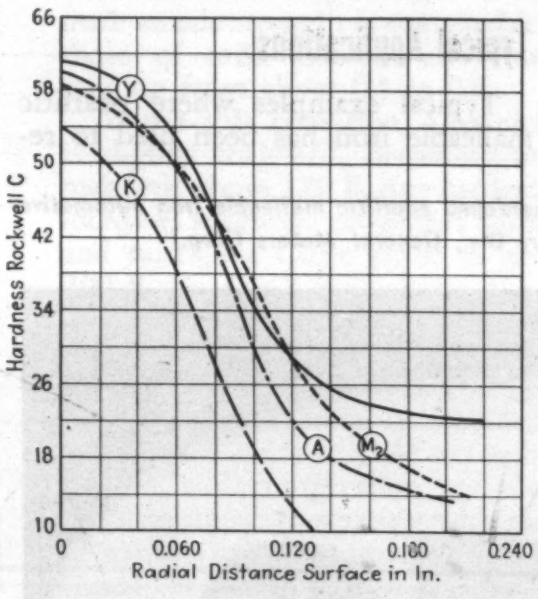


Fig 3—Hardness vs depth of case of some commercial flame hardened pearlitic malleable irons.

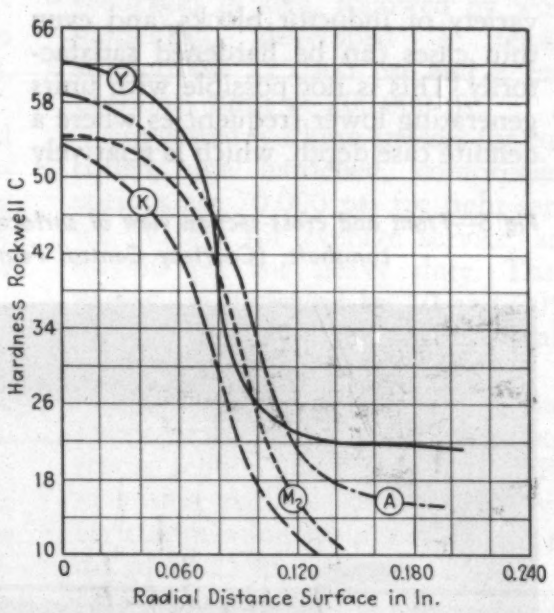
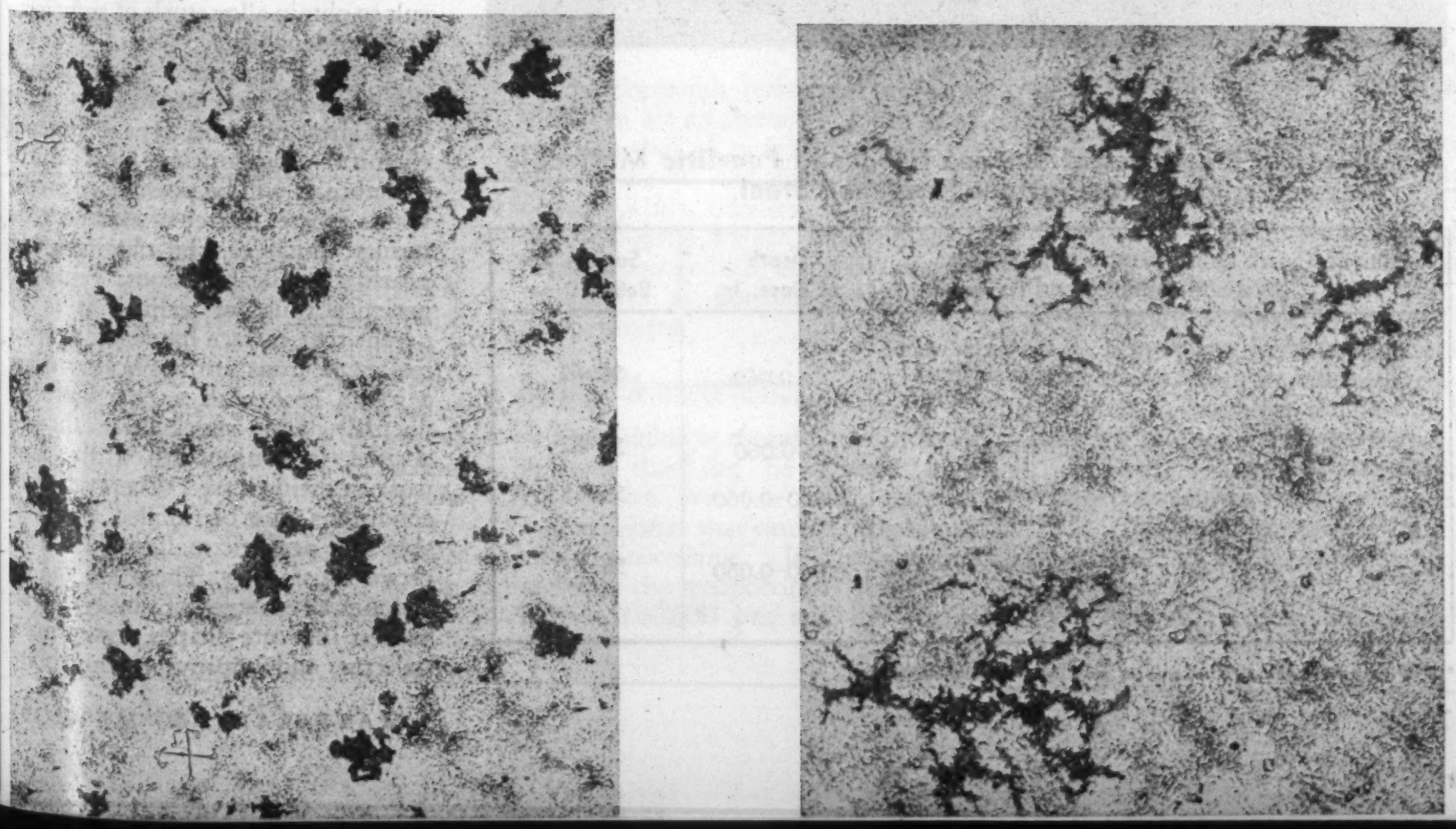


Fig 4—Hardness vs depth of case of some commercial induction hardened pearlitic malleable irons.

Fig. 2—Differences in graphite size, shape and distribution, as shown here, have no apparent effect on hardening properties. (1000X)



to surface harden in an induction unit by stationary, spinning, progressive or combination techniques using a spray or immersion quench.

Frequencies ranging from 3000 to 350,000 cycles have proved to be satisfactory. In general, case depth is much greater at the lower frequencies, with non-uniformity in hardness and microstructure. At higher frequencies, due to the skin effect, this difficulty is eliminated.

While it is possible to use frequencies as low as 2200 cycles or as high as 400,000 cycles, for general use where a uniform case of average depth is desired, a 9600-cycle unit capable of delivering 75 to 100 kw is best. Such a unit will operate with a large variety of inductor blocks, and even thin cases can be hardened satisfactorily. This is not possible with units generating lower frequencies where a definite case depth, which is relatively large, must be reached before the surface of the case becomes uniform in hardness. High frequencies, 200,000 to 300,000 cycles, are very satisfactory, particularly where a thin case is desired.

The curves in Fig 4, representing several typical commercial pearlitic malleable irons, show hardness and depth of case obtained by induction hardening at 9600 cycles for 2 sec. Curve Y represents the iron having the most satisfactory microstructure, consisting of a matrix of finely spheroidized cementite.

Induction hardening can be satisfactorily applied to such parts as cam shafts, refrigerator crank shafts, bearing surfaces and small gears.

Typical Applications

Typical examples where pearlitic malleable iron has been used to replace steel are in cam shafts, in gears, or in refrigerator crank shafts.

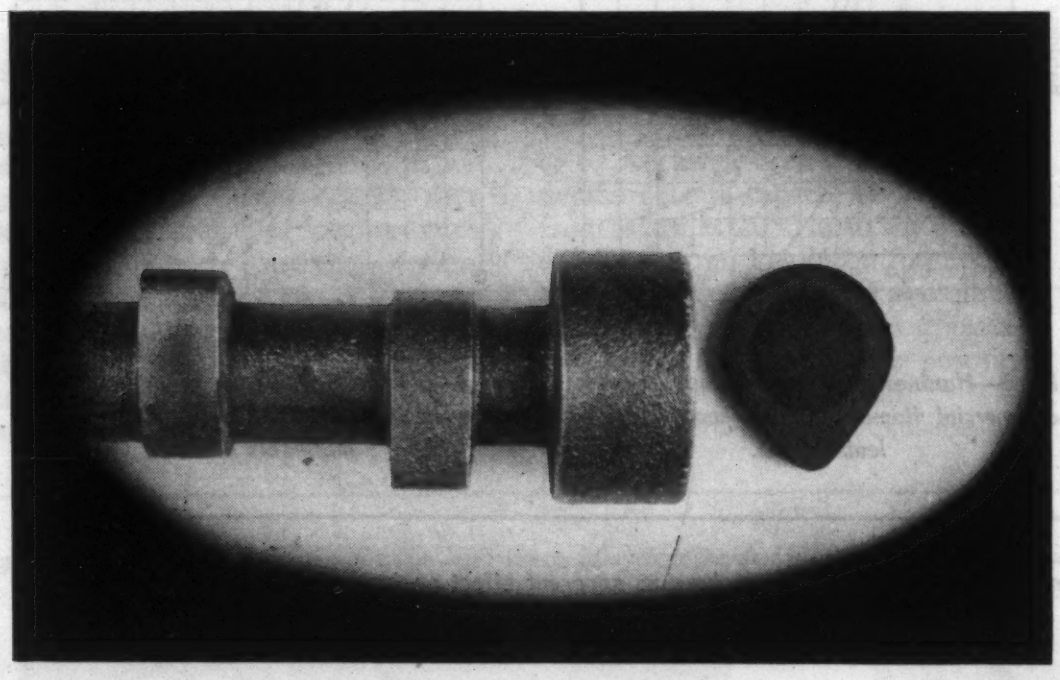
In producing a forged steel crankshaft or camshaft, the normal operations consist of heating and forging the billet, normalizing, carburizing, hardening by quenching, drawing, grinding and inspecting. On the other hand, the operations to produce a pearlitic malleable camshaft are casting, malleablizing, flame or induction hardening, grinding and inspecting. The procedure for small crankshafts is the same as it is for camshafts.

Fig 5 shows front and cross section views of a surface hardened pearlitic malleable iron automotive camshaft. The step-by-step sequence of operations for such camshafts is as follows: (1) After insertion of the camshaft it is fed through one inductor where adjustments can be made so that the shaft stops when a cam is positioned in the inductor block; (2) the heating cycle goes on, then off; (3) the cam is spray quenched and the shaft then moves until the next cam is in position, and the operation is repeated until all of the cams are hardened. Adequate control of power input and heating time insures a case satisfactory in hardness and in depth.

Steel gears are normally alloyed sufficiently so as to raise the hardenability to the point where an oil quench can be used after the flame or induction treatment to eliminate or minimize distortion due to quenching. The steel gears are usually forged from blanks and are then flame or induction hardened. Pearlitic malleable gears have been found a satisfactory replacement for alloy gears in some applications. Their use for such parts in non-critical applications should increase, since it is proving more difficult to obtain alloy steels of sufficiently high hardenability.

With an increased knowledge of the effect of such variables as power input, heating time, type of quench, chemical composition and microstructure, it will be possible to predict with a greater degree of assurance, the results which can be obtained with pearlitic malleable irons. From experience thus far gained, it is apparent that surface hardened pearlitic malleable irons are applicable where a tough core with a fair degree of ductility and shock resistance is desired, in conjunction with a hard wear resisting case. Wherever these conditions must be fulfilled, it is probable that pearlitic malleable iron will prove satisfactory. There are the additional advantages of ability to case harden intricate shapes, lower material cost, and improve machinability.

Fig 5—Front and cross-section view of surface hardened pearlitic malleable iron automotive camshaft. (Courtesy Central Foundry Div., General Motors Corp.)



Comparative Properties of Surface Hardened Pearlitic Malleable Iron and Surface Hardened Steel

Part	Material	Heat Treatment	Depth of Case, In.	Surface Rc Before Draw
Automotive Camshaft	Steel carb. case	Carburize, water quench, draw	> 0.060	58–62
Automotive Camshaft	PMI	Induction harden	> 0.060	58–62
Gear	Alloy steel	Flame harden	0.040–0.060	53–58*
Gear	PMI	Flame harden	0.040–0.060	58–62

** Will vary with the steel. Hardness may be greater than 60 Rc.*

Nickel-Aluminum Alloy Combines Strength and Corrosion Resistance

by **PHILIP O'KEEFE**, Assistant Editor, Materials & Methods

Duranickel promises to find wide use where high hardness and great strength at room and high temperatures is required in addition to excellent corrosion resistance.

• DURANICKEL IS A relatively new corrosion resistant nickel-aluminum alloy developed by The International Nickel Co. It is a wrought, slightly magnetic metal with the strength of heat treated alloy steel, and with strength and hardness superior to comparably priced corrosion resistant alloys. Principal applications are in equipment requiring some combination of corrosion resistance, high hardness, and high room or elevated temperature strength.

Its nominal chemical composition is:

Nickel	93.7 %
Copper	0.05
Manganese	0.3
Iron	0.35
Aluminum	4.4
Silicon	0.5
Carbon	0.17
Sulfur	0.005

Properties

Strength and hardness are increased by cold working and by age hardening. Impact strength decreases with increasing hardness but brittleness is not found at strengths as high as 200,000 psi. Values of Vickers hardness increase from 140 in the unworked condition to 330 at 70% reduction, and tend to increase with tensile strength, yield strength and proportional limit at a rate that decreases with age hardening in cold drawn, hot rolled and annealed specimens.

The mean coefficient of expansion increases from 5.8×10^6 at —250 F to 8.3×10^6 at 1000 F. The ratio of maximum shearing strength to ultimate tensile strength is comparable to those of mild and low-alloy steel, ranging from about 0.5 to 0.6.

In the soft condition, Duranickel is slightly magnetic, becoming nonmagnetic above 120 F. Age hardening increases magnetic properties slightly and raises the Curie point to about 200 F.

Stress-strain curves show true elastic properties with no gradual deviations. The modulus in tension is equal to that in compression, *i.e.* 30,000,000 psi, and the ratios of yield strength in tension and compression are about equal to unity, comparing with those of carbon and alloy steels. The torsional proportional limit of cold-drawn and age-hardened wire is about 40% of the ultimate tensile strength.

Tests indicate that compression overloads will cause a permanent set, rather than a sudden fracture. Test pieces tended to barrel out, with increases of 20% in area and decreases of 15% in height being reached at the ultimate extension of the test machine without a single case of fracture.

The corrosion resistance of Duranickel in all its forms is of the same order as that of nickel to a wide variety of media, including mineral and organic acids, alkalies, salts, potable and industrial waters, food products, organic compounds, and oxidizing atmospheres at normal and elevated temperatures.

Spring Characteristics

Duranickel is useful both for small springs that can be formed from cold-drawn wire or rods and for larger springs that cannot be made by cold processing. In cold-drawn springs, the proportional limit may exceed 100,000 psi, and the tensile strength may go over 200,000 psi, depending on wire size and the cold work developed in coiling. A 75% reduction in area, followed by work hardening, developed a tensile strength of 225,000 psi and a proportional limit of 200,000 psi.

Suggested working stresses for cold coiled, age hardened, compression springs are 70,000 psi for light service, 60,000 for average service, and 45,000 psi for heavy duty. These values are increased by 10 and 20% for wire sizes below 0.057 in. and 0.020 in., respectively.

Suddenly applied loads, elevated temperatures, and additional torsional forces reduce allowable stresses. For extension springs, the values given for compression springs should be reduced by 25 to 33%.

With average or reduced stresses, Duranickel springs can be used up to 550 F; the stresses used will be governed by application conditions.

Working Characteristics

Duranickel is considerably different from nickel in working, comparing more closely with K monel. Exposure at high temperatures to sulfurous atmospheres or to lead and other low-melting point metals and alloys, must be avoided.

The best conditions for heating are a sulfur-free, reducing atmosphere with a minimum carbon monoxide content of 2%; in a strongly oxidizing atmosphere, the alloy takes on a heavy oxide coating.

Important factors in heating are:

1. Low-sulfur fuels, and reducing atmospheres must be used in furnaces designed to complete combustion before the hot gas strikes the metal.
2. Furnace must be at desired temperature when work is charged.
3. Time and temperature must be controlled to avoid excessive grain growth.
4. Heating atmosphere must be

uniform and constant.

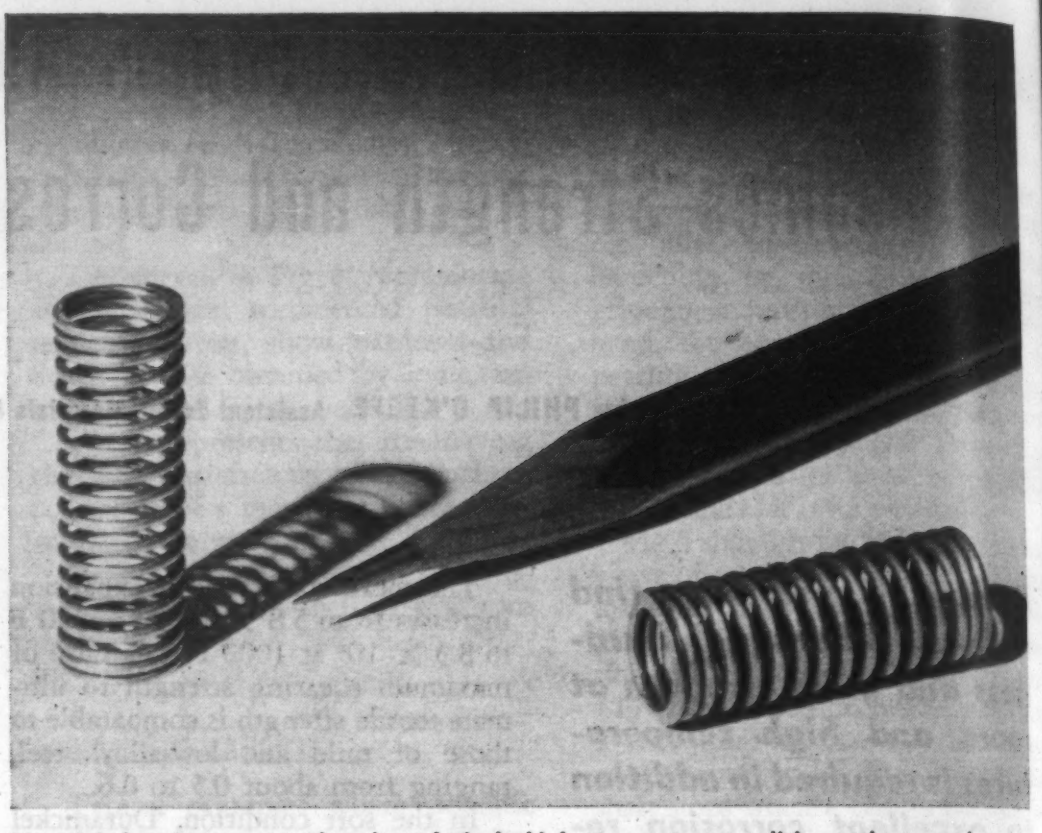
Hot working should be carried out from an initial metal temperature of 2300 F; damage to the material is likely to occur above that temperature. The best range for heavy forging and bending is 2300 to 1900 F, but light, finishing work can be carried down to about 1600 F. The material stiffens so rapidly below about 1800 F that heavy reductions can be done more economically following reheating. Forging below 1600 F is not recommended. The alloy should not be allowed to cool in air but should be quenched from a temperature of 1450 F or higher to avoid the appreciable age hardening which results from slow cooling and may cause cracking or surface tears during subsequent heating. The surface of the forging will be less oxidized and easier to pickle if quenched in water containing about 2% (by volume) of alcohol.

Annealed Duranickel can be drawn, formed, upset, bent, swaged or otherwise cold worked. Although more power is required than with nickel, because of greater hardness and work hardening, the high ductility of the alloy permits severe deformations without damage. The rate of work hardening is similar to that of Inconel.

Duranickel is machined most readily in the annealed condition, and is commercially machinable in other conditions at hardnesses up to 275 Bhn. Harder material can be machined at slower speeds with cemented-carbide tools, but this is not economical and can usually be avoided by doing the bulk of the machining before age hardening. Little warpage from age hardening is encountered since the temperature and rate of cooling are low. Surface oxidation is slight and can be removed readily by finish machining or grinding.

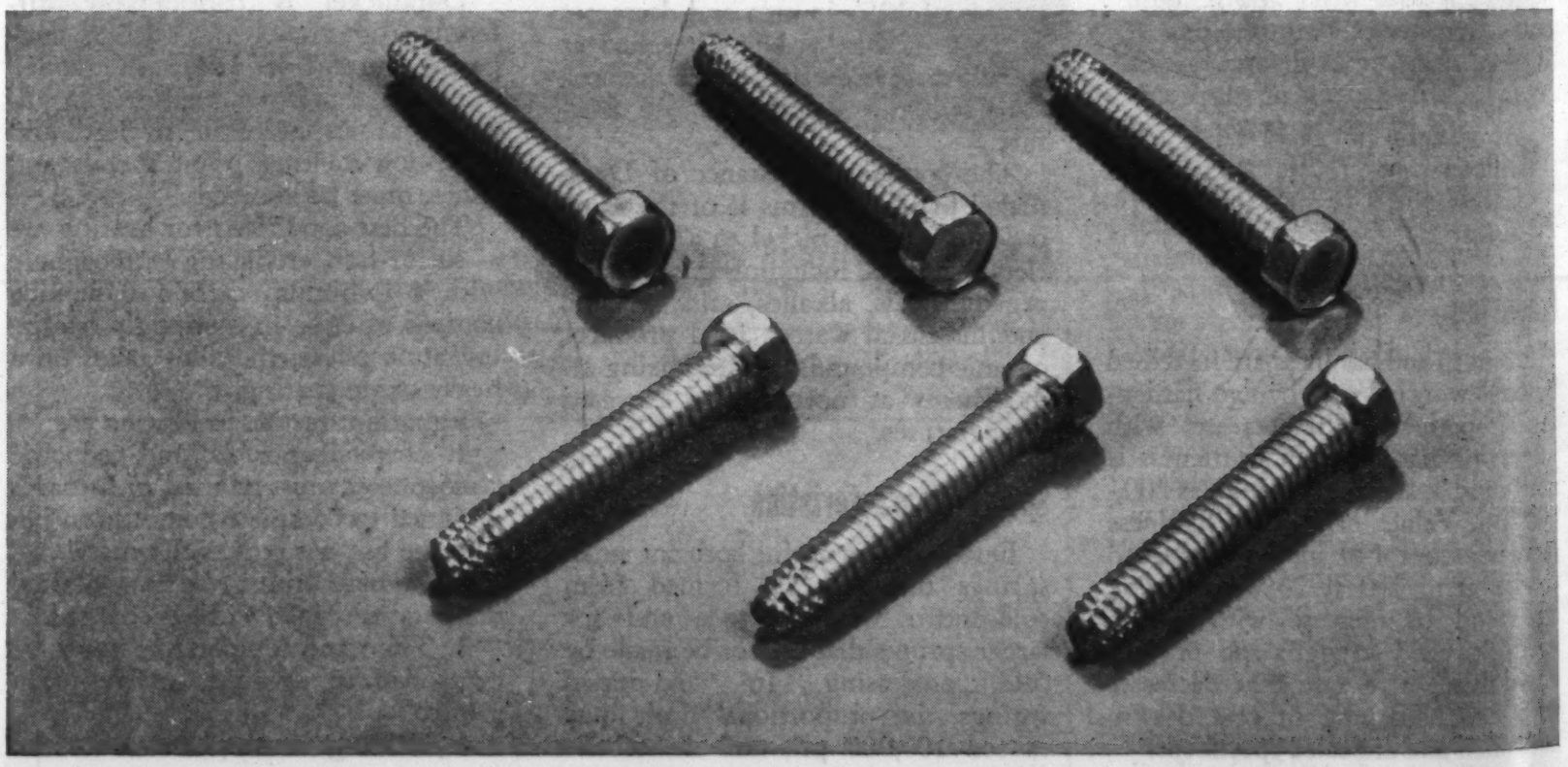
When the best possible surface finish is desired, the use of age-hardened material is preferred for the final cuts. When considerable machining is to be done, soft material should be used and age hardened afterward. The choice is largely a matter of individual preference.

Tool design is of utmost importance. Relatively blunt-nosed tools with sharp cutting edges, supported rigidly on sturdy machines with as little overhang from the tool post as possible, should be used. Clearance angles should be held to a minimum.



Duranickel springs are used under relatively high temperature conditions, where good corrosion and fatigue resistance are required.

Corrosion resistance is combined in Duranickel with greater hardness and strength than is possible with nickel parts.



Secondary clearance angles, with a land of 1/32 to 3/64 in., help to support the cutting edge and prolong tool life.

A special alloy, Duranickel "R," containing a higher percentage of carbon, is available in annealed and cold-drawn rod and bar forms for special applications requiring optimum machinability. The speeds for machining Duranickel "R" are not exceedingly higher, but the special material cuts more freely and cleanly and insures longer life to cutting tools between tool grinds. Duranickel "R" has best machinability in the annealed condition, but its improved machinability is retained to a certain degree in the age-hardened condition.

When grinding age-hardened Duranickel, it is imperative to avoid excessive heating, which will decrease hardness, by using an ample amount of water or other liquid coolant. Surface grinding with magnetic chucks is not possible, owing to the low magnetic characteristics of the alloy; vacuum-type chucks are being used satisfactorily.

Before pickling, all grease and dirt should be thoroughly removed. The pickling solution itself is chosen to fit the heating processes that have been carried out on the alloy. Duranickel which has been heated and cooled in a reducing atmosphere or has been alcohol-water quenched can be pickled in warm sulfuric acid solution with sodium nitrate and chloride. If a thick oxide scale is present, a two-dip process is necessary. The first bath is a strong solution of hydrochloric acid and copper chloride; the second is a strong mixture of sulfuric and nitric acids.

The inert gas metal arc welding method is recommended for Duranickel. Protection of the root side of the weld by a suitable flux or gas shield is necessary to prevent excessive oxidation and erratic penetration. Welds which respond to age hardening in the same order as the parent metal can be made with the a.c. or d.c. arc, shielded by either helium or argon.

Thermal Treatment

Before any thermal treatment, dirty surfaces and contamination by sulfur from furnace atmospheres or lubricants must be cleaned and degreased thoroughly, as described previously, because these, particularly sulfur-bearing materials, can cause intercrystalline attack and embrittlement at the elevated temperatures.

To prevent surface contamination and obtain the best surface condition, annealing or age hardening should be done in protective atmospheres, such as dry hydrogen, or highly reducing proprietary gases, with a dew point of at least —50 F.

Bright hardening or bright annealing of this alloy is not possible, unless the operation is carried out in a vacuum, since the alloy contains minor alloying constituents which form very stable oxides. Some surface oxidation and discoloration will result even with hydrogen dried by commercial practice. This oxide is a very thin and tenacious film that is not unsightly and can be removed readily by mechanical or chemical cleaning.

The alloy should not be held at temperature longer than is necessary to insure the desired degree of softness; excessive time at temperature will result in grain growth. Coarse-grained material cannot be employed normally for deep drawing or heavy forming because it will develop a pebbled or orange-peel surface.

Closed annealing, as is done with nickel, is not possible with Duranickel because the latter material will age harden appreciably upon slow cooling from the annealing temperature.

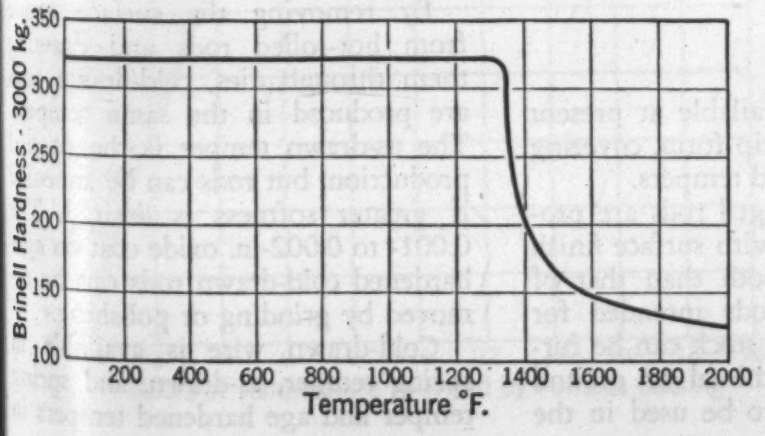
Duranickel is hardened by a single heat treatment consisting of aging at the required temperature. Cold-worked material responds more rapidly than soft material and requires less time and/or lower temperature. To obtain the maximum mechanical properties, the age-hardening treatment must be followed by controlled slow cooling. No preliminary quenching treatment is required. The alloy must not be heated above the specified age-hardening temperature if softening is to be avoided.

Age hardening can be done either in air or in a reducing atmosphere. If done in air, the parts will have a superficial oxide coating 0.0005 to 0.001 in. thick. Unless the parts are extremely thin, such a film will have no detrimental effect. If discoloration can be tolerated or if the material is to be pickled or polished subsequently, there is need only for a sulfur-free, non-oxidizing atmosphere. Suitable atmospheres are hydrogen, cracked ammonia, nitrogen, cracked and sulfur-free natural or city gas, or a generated atmosphere containing a reducing combination of two or more of carbon monoxide, carbon dioxide, hydrogen, nitrogen and hydrocarbons. If a bright finish is required, it will be necessary to pickle or polish after age hardening.

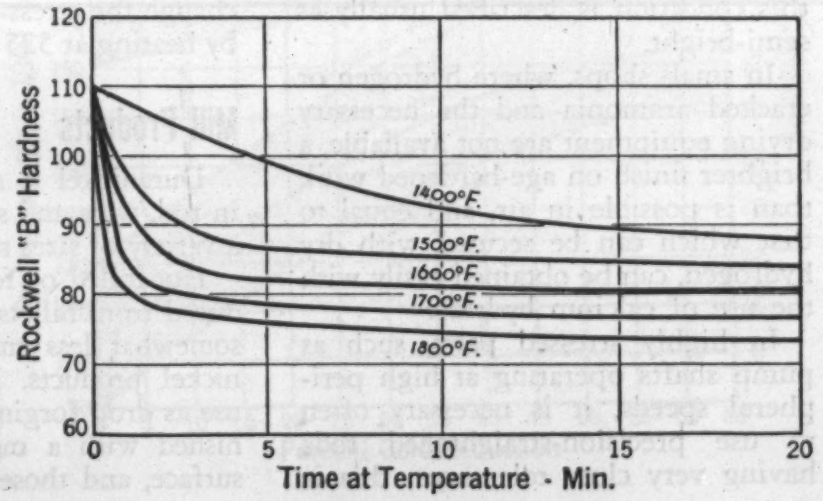
In some instances it may be desired to age harden the material to less than the maximum hardness. This can be achieved by decreasing both the time at which it is held at temperature and the cooling period.

Duranickel can be age hardened in a perfectly bright condition only in

The softening effect of water quenching on Duranickel increases sharply from temperatures above 1300 F.



Approximate time required to produce different degrees of softness in Duranickel by open annealing.



Impact Strength

Property	Hot-Rolled		Cold-Drawn	
	As-Rolled	Age-Hardened	As-Drawn	Age-Hardened
Charpy Impact, U Notch	240+	36*	190	41*
Izod Impact, U Notch	120+	25*	120+	25*
Tension Impact				
Ft-Lb	135*	113*	—	112*
Elong in 3.54 In., %	24.5	9.5	—	6.0
Reduction of Area, %	68.8	22.2	—	32.9
Torsion Impact				
Ft-Lb	38	19*	45	27*
Ft-Lb per Sq In.	750	385	908	547
Angle of Twist, Deg	99.5	26.0	96.0	40.0

* *Specimen fractured completely.*

Physical Constants

Density, Lb/Cu In.	0.298
Specific Gravity, Gm/Cu Cm	8.26
Melting Range, F	2550–2620
Mean Coefficient of Thermal Expansion, In./In./F (77-212 F)	0.0000072
Thermal Conductivity, Btu/Sq Ft/Hr/F/In. (32-212 F)	128/137
Electrical Resistivity, Ohms/Cir Mil Ft, 68 F	280/260
Electrical Resistivity, Temperature Coefficient, per F (68-212 F)	0.0006
Modulus of Elasticity, in Tension, psi	30,000,000
in Torsion, psi	11,000,000
Poisson's Ratio (Estimated)	0.31

Endurance Limit

Condition	Endurance Limit, psi			Ten Str, Psi	Endurance Ratio
	10^6 Cycles	10^7 Cycles	10^8 Cycles		
Hot-Rolled	54,500	52,000	51,000	105,500	0.47
Hot-Rolled, Age-Hardened	74,000	62,000	52,000	182,000	0.29
Cold-Drawn	65,000	58,000	51,000	175,000	0.29
Cold-Drawn, Age-Hardened	77,500	66,000	61,000	200,500	0.30

Compressive Properties

Property	Hot-Rolled		Cold-Drawn	
	As-Rolled	Age-Hardened	As-Drawn	Age-Hardened
Compression				
Yield Strength (0.2% Offset), 1000 Psi	51	148	103	165
Proof Stress (0.01% Offset), 1000 Psi	34	117	58	122
Tension				
Ultimate Strength, 1000 Psi	105	177	132	198
Yield Strength (0.2% Offset), 1000 Psi	52	138	107	162
Proof Stress (0.01% Offset), 1000 Psi	40	106	73	115
Elong in 2 In., %	41	16	27	16
Hardness				
Brinell (3000 Kg)	147	375	245	381
Rockwell C	12	39	23	42
Vickers (30 Kg — Diamond Pyramid)	202	386	250	400

Hot-Rolled, Age-Hardened Properties

Temp, F	Ten Str, Psi	Yld Str, 0.2 % Offset Psi	Elong % in 2 In.	Red. of Area, %	Mod of Elast 10^6 Psi	
					Tens.	Tors.
Room	185,000	132,000	28.0	55.5	30.0	11.00
600	168,000	120,000	29.0	57.0	28.1	10.00
700	163,000	117,000	27.0	57.0	27.8	9.75
800	155,000	114,000	24.0	46.0	27.2	9.45
900	141,000	109,000	11.0	19.0	26.8	—
1000	118,000	99,000	7.0	14.0	26.3	—
1100	94,000	75,000	4.5	10.0	25.9	—
1200	69,000	54,000	4.0	7.0	—	—
1300	42,000	34,000	7.5	11.0	—	—
1400	25,000	14,000	60.0	66.0	—	—
1500	16,500	9,400	98.0	92.0	—	—

vacuum. Aging in dry hydrogen, —58 F dew point, or cracked ammonia will produce a light oxide which is less than that resulting from aging in air, and which can be removed readily by bright-dip pickling; this condition is described usually as semi-bright.

In small shops, where hydrogen or cracked ammonia and the necessary drying equipment are not available, a brighter finish on age-hardened work than is possible in air, and equal to that which can be secured with dry hydrogen, can be obtained easily with the use of calcium hydride.

In highly stressed parts, such as pump shafts operating at high peripheral speeds, it is necessary often to use precision-straightened rods having very close tolerances; this is particularly true of smaller diameter rods, under 1 in. dia. Should it be necessary to hand-straighten age-hardened material, the rods should be given a stress-equalizing subsequently to remove any locked-up stresses and change the stress-distribution pattern by heating at 525 F for 3 hr.

Mill Products

Duranickel is available at present in rod, wire and strip form, covering a variety of sizes and tempers.

Hot-rolled or forged rods are produced from billets with surface finish somewhat less smooth than that of nickel products. Rods intended for use as drop forging stock can be furnished with a machined or ground surface, and those to be used in the manufacture of bolts and hot-upset head rivets can be supplied with special tolerances to meet the major diameter tolerances of fine thread. Hot-rolled or forged rods come in as-rolled, as-rolled and age hardened, annealed, and annealed and age-hardened tempers.

By removing the surface oxide from hot-rolled rods and drawing them through dies, cold-drawn rods are produced in the same tempers. The as-drawn temper is the normal production, but rods can be annealed if greater softness is desired. The 0.001- to 0.002-in. oxide coat on age-hardened cold-drawn rods can be removed by grinding or polishing.

Cold-drawn wire is available in spring temper, as-drawn, and spring temper and age hardened tempers in

addition to the above. Intermediate tempers to provide the highest strength and hardness consistent with fabricability can be produced by varying the amount of cold reduction. The selection of spring-temper wire, in the as-drawn condition, will be governed by the amount of bending and forming to be performed.

Annealed strip will be very slightly discolored, but the discoloration is not generally sufficient to warrant pickling. Strip in half-hard or spring tempers will vary from bright to slightly discolored, depending upon the number of intermediate anneals, and will not be perfectly flat.

Applications

Just as nickel is usually chosen because corrosion resistance is required, so the choice of Duranickel nearly always involves that condition; a second major requirement is usually higher hardness and greater strength at room and at elevated temperatures than is possible with nickel.

Duranickel springs, made from both wire and strip, have good resistance to fatigue and are giving excellent service under many corrosive conditions at room temperatures, such as laundry clips, jewelry parts, optical frames, infra-red bulb spring contacts, springs in sunlamps and spark plugs, and shaker springs on paper machinery. In electric toasters, the springs operate effectively at temperatures up to 600 F.

Established uses as instrument parts include diaphragms; bellows; flapper valve disks; snap switch blades; the flexible bridge in a phonograph pick-up assembly; hands and numbers on watches used by the blind; stylus, pen, joints and bearings in telautograph equipment; and grid wires and side rods in vacuum tubes.

In the production of thermoplastic and thermosetting plastics, the high hardness and corrosion resistance of Duranickel, particularly to prevent contamination by copper, have made it a standard material for extrusion and injection dies and contribute to its usefulness as injection cylinders, extrusion screws, self-tapping screws, plunger rods, cutters, and other equipment parts.

Other recent developments are molds for sunglass and camera lenses; self-tapping screws for securing into steel purlings; and bearings, pump parts, valves and accessories in equipment handling hydrofluoric acid and fluorine. In the preparation of foodstuffs, Duranickel scraper blades are used to remove cocoa, chocolate and sugar from drum dryers.

Permanickel

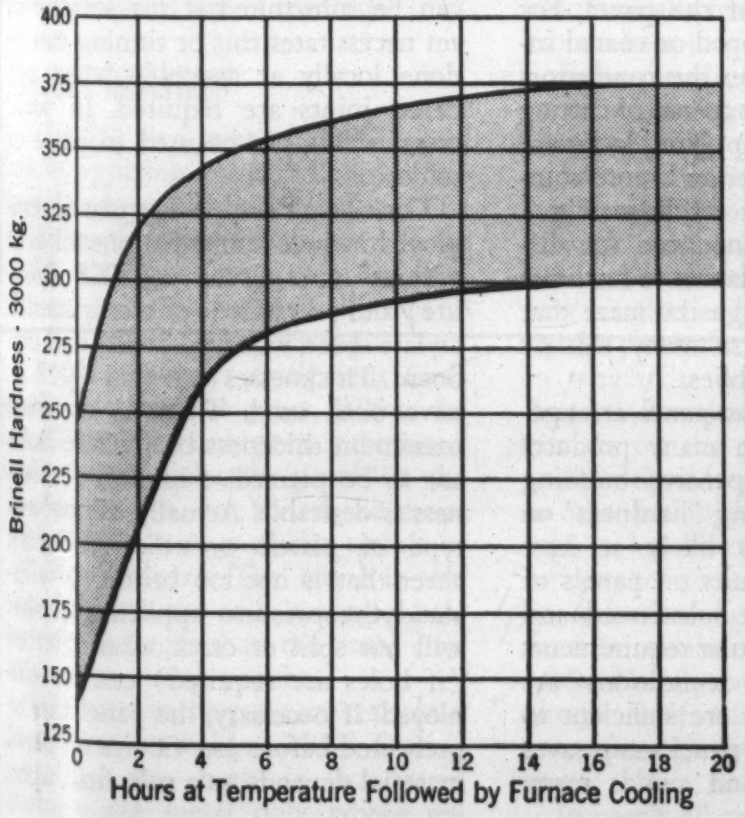
Permanickel is an age-hardenable, high-nickel alloy having the same mechanical properties and resistance to corrosion as Duranickel but different physical constants.

Because of these differences, Permanickel is preferred to Duranickel for a few services, such as springs requiring high electrical conductivity, parts of equipment requiring good thermal conductivity, and magnetostrictive units which are operated under stress conditions for which the fatigue strength of nickle is inadequate. Special applications include thermostat tension springs, the pendulum-type spring in railroad code transmitters, a reaction spring which holds the clapper arm in buzzers and warning bells, contact brushes, clips, and grid wires and side rods in vacuum tubes.

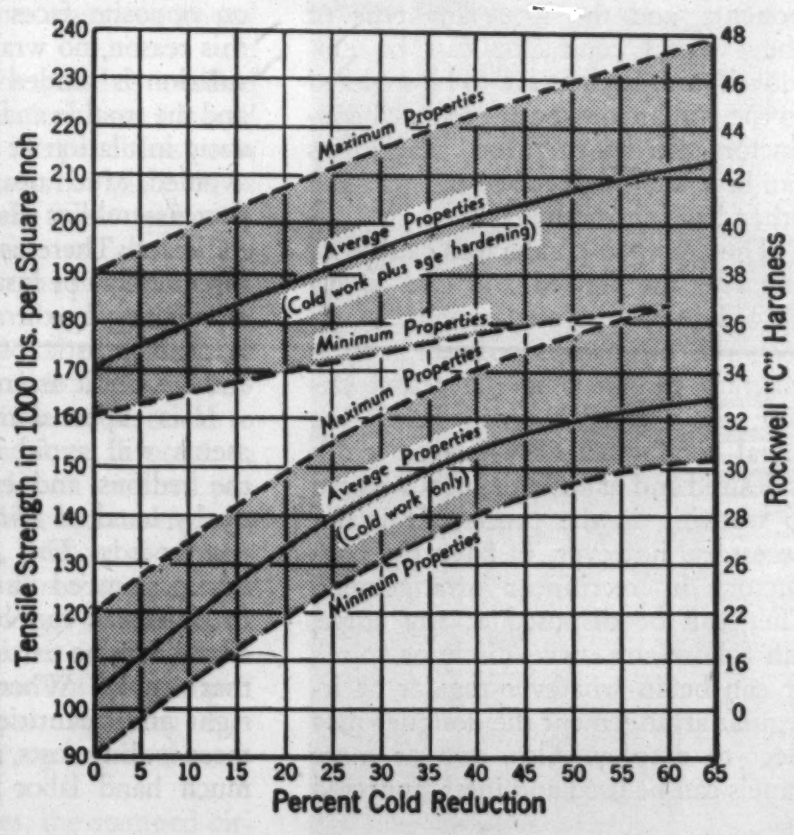
Joining Processes

Process	Generally Applicable to Material Thickness In.
Metal Arc	0.050 and over
Atomic Hydrogen	0.125 and under
Inert Gas Metal Arc	0.125 and under
Oxyacetylene	0.125 and under
Resistance Welding	
Spot	0.125 and under
Seam	0.125 and under
Projection	0.125 and under
Flash	0.050 and over
Silver Brazing	All thicknesses
Soft Soldering	All thicknesses

Age hardening of Duranickel. Effect of time at temperature (1080 to 1100 F). Shaded area indicates range for commercial production.



Effect of cold work and age hardening on Duranickel. Heavy, full lines indicate average properties. Shaded areas cover ranges of commercial products.



Stamped Electrical Circuits Yield Compact, Low Cost Assemblies

by HERBERT CHASE

Thin metal strip conductors stamped into dielectric materials have numerous advantages in electrical and electronic equipment.

● THE ENGINEERS OF THE Franklin Airloop Corp. have devised and patented a new and highly economical method of producing electrical circuits. The new process provides assemblies having numerous advantages in electrical and electronic equipment.

Basically, the process involves stamping circuits from thin sheet metal and, at the same time, applying them securely to one or both sides of a plastic or other dielectric panel. Excess metal is stripped off and holes are pierced where needed to apply eyelets or pins and supplementary assemblies, such as electronic tube bases, clips for resistors, inductors, capacitors, fuses, plugs, switch components, and the like. Any type of sheet metal conductor can be employed and, if parts are to be soldered to the conductors, both parts and conductors can be pretinned and joints can be made by electrical resistance or other heating methods.

The stamped conductors can be of any contour desired and can be arranged in almost any pattern. In effect, the ordinary rectilinear wiring diagram can become the actual circuit, the "lines" thereon being the metal conductors of whatever width is desired and of any thickness adapted to working in the process. It is not necessary, however, to have the conductors in rectilinear arrangement. They can be disposed at any angle, can follow any curve, circle or spiral, or can be in whatever regular or irregular arrangement the designer may elect to employ. Also, two or more panels can be used and interconnected in any pattern to meet the designer's needs. Where circuits are required to cross or be carried through the panel, parts of the circuits are usually applied to both sides, with the conductors on one side running in one direction and those on the other side in a different direction. Conductors to join the two sides of a panel are commonly eyelets, but other forms, such as rivets, pins or screws, can also be used. It is a simple matter to arrange circuits so that any point or points on one side can be connected to any point or points on the reverse side.

With circuits on both sides, crossovers on either side are not needed because they can be arranged to occur on opposite faces of the panel. For this reason, no wrapped or coated insulation is needed on the conductors and the trouble and expense of cutting away insulation or applying loom are avoided. Much neater and more compact assemblies also result, as Fig 1 indicates. There is no need for different colors of insulation to facilitate circuit tracing through the maze that is characteristic of so many electric and electronic assemblies.

It is expected that panel arrangements will avoid in many products the tedious and expensive building up by hand of wiring "hardness" on peg boards. This is likely at least where stamped circuits on panels of feasible size can be substituted and adapted to the particular requirements that apply. Where conditions are right and quantities are sufficient to meet tooling costs, a panel setup saves much hand labor and avoids many complications encountered in making wiring hardnesses. Weight may also be decreased.

Materials Used

Conductors—Any metal that can be stamped can be used for the conductors. Thicknesses should be between 0.003 and 0.010 in. To date, electrolytic copper, tinned or silver-plated copper, plain or tinned brass, silver and aluminum have been employed, chiefly because they are good and conventional conductors, are readily worked, and are quite resistant to corrosion. Tin plating is desirable where soldering is to be done but is not essential, and zinc or other plating can be substituted if the scarcity of tin necessitates this or tinning can be done locally at assembly when soldered joints are required. In some cases, welds can be used in place of soldering.

Dielectric Panels—The plastics employed include laminated phenolics of various types (such as XXP Bakelite) and polystyrene or methylmethacrylate sheet, wood, Masonite and tagboard. Thicknesses as low as 0.012 in. have been used. There is no fixed maximum thickness but, where holes are to be pierced, a moderate thickness is desirable. Actually, almost any type of plastic or other dielectric sheet that is not too brittle to withstand the pressure applied and that will not split or crack when pierced (if holes are required) can be employed. If necessary, the panel can be preheated before use. Choice of panel material depends, as a rule, first, upon

meeting dielectric, structural and other physical requirements (such as stiffness, dimensional stability and moisture resistance) and, secondly, on keeping costs moderate and appearance satisfactory.

As a rule, the base panel material is of the type produced in sheet form, but application to molded plastic panels or other moldings is feasible provided the surface is flat and the plastic part is not brittle and can withstand the pressure applied. Paper and other materials not classified as plastics are useful provided they are sufficiently nonhygroscopic and possess other characteristics suitable for service requirements.

Adhesives—With the type of die employed, the metal conductors are not only sheared cleanly but the edges cut are forced into the plastic or other backing used. This action affords a mechanical binding that, in some cases, might be sufficient to meet requirements. In practice, however, an adhesive is always applied to the face of the metal in contact with the panel. Occasionally, especially with panels that are unusually hard or glossy, the face of the panel is also coated with adhesive but, with Masonite of ordinary hardness (which has been most commonly used to date) only the metal has needed such coating.

The adhesive used is Kotol, a U. S. Rubber Co. product, which air dries quickly. However, it is given a short bake to accelerate drying and to facilitate handling coils of the metal. Other adhesives doubtless could be employed but, since Kotol has proved satisfactory, its use is continued.

Process Described

The first step in the Franklin process is applying the adhesive on the metal strips used for the circuits. The adhesive is applied automatically by roller coating the metal strip and then drying by infra-red radiation. The metal is recoiled after coating.

Automatic roller equipment feeds the metal into the press. When the die closes, it not only presses the metal against the dielectric panel in the pattern desired, but shears the metal around the contour of the circuit or circuits produced. The metal is also sheared from the coil, leaving a hole somewhat larger than the outer contour of the circuit pattern.

Dies used in the press are resistance heated and are held at 230 F. During pressing, the heat is conducted through the metal only where the pressure is applied, thus softening the adhesive which adheres to the panel only at those points. In other areas the adhesive is not affected, hence the excess metal can be stripped off easily.

Panels to which circuits are to be applied are blanked out and often some holes are pierced in conventional punch presses before the panels go to the presses that apply the metal circuits. Two types of presses have been used. One, of standard make, Fig 2, is mechanically operated by a toggle mechanism and the other is of HPM hydraulic type. Any press capable of applying sufficient pressure and of giving a long enough dwell to permit heat to penetrate the metal and soften the adhesive where the pressure is applied can be employed.

Panels coming from the press are transferred to benches where operators strip off the surplus metal. If the circuit design involves islands of metal, a knife or scriber may be required to pick up the island and lift it from the panel. Large islands, such as those at the center of large coils, often fall free if the panel is turned over and lightly tapped.

After removing all excess metal, the panels, with the stamped circuit complete, usually go to punch presses where any holes needed and not already in the panel are pierced. These holes are chiefly for eyelets or pins that pierce both the metal and the panel, but any number of other holes needed can be pierced at the same time. Application of eyelets or pins is done on conventional machines, often of a type that feeds the parts automatically from a magazine loaded from a hopper.

Subsequently, the panel is handled much as any equivalent panel would be except that, as the panel has most or all of the circuits in place, it is not necessary to add wires except to connect components not already on the panel or to join the panel to whatever auxiliaries have to be connected in the particular piece of equipment in which the panel fits. Where soldered connections are to be made to circuits on the panel, it is usual to apply a tinned eyelet or a tinned pin or other fitting. Soldering is then done with a hand iron, carbon electrodes or by other conventional means, such as induction heating. Where costs must be minimized, it is possible to solder directly to parts of the stamped circuit itself without applying eyelets, pins or other secondary fastenings.

In nearly all cases, the stamped circuit lies entirely within and is fastened

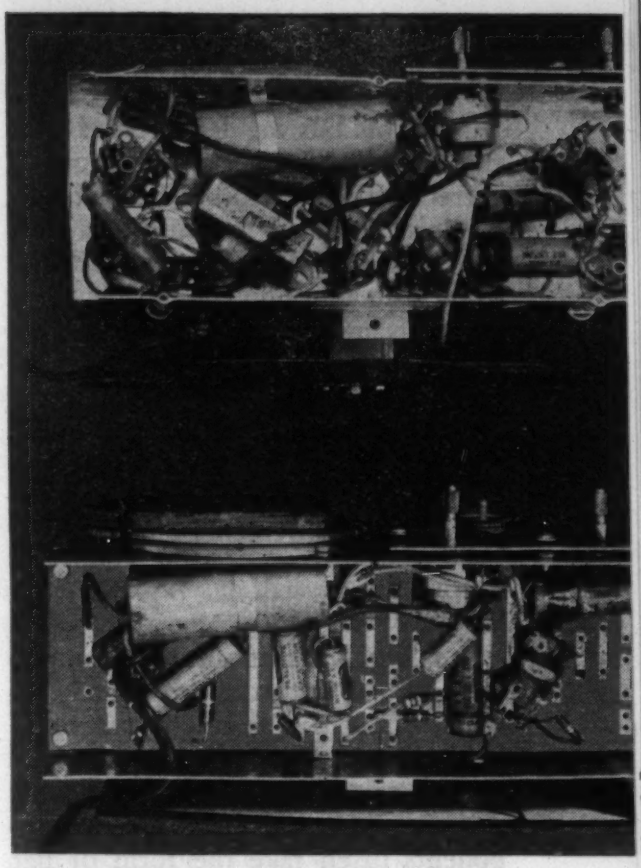
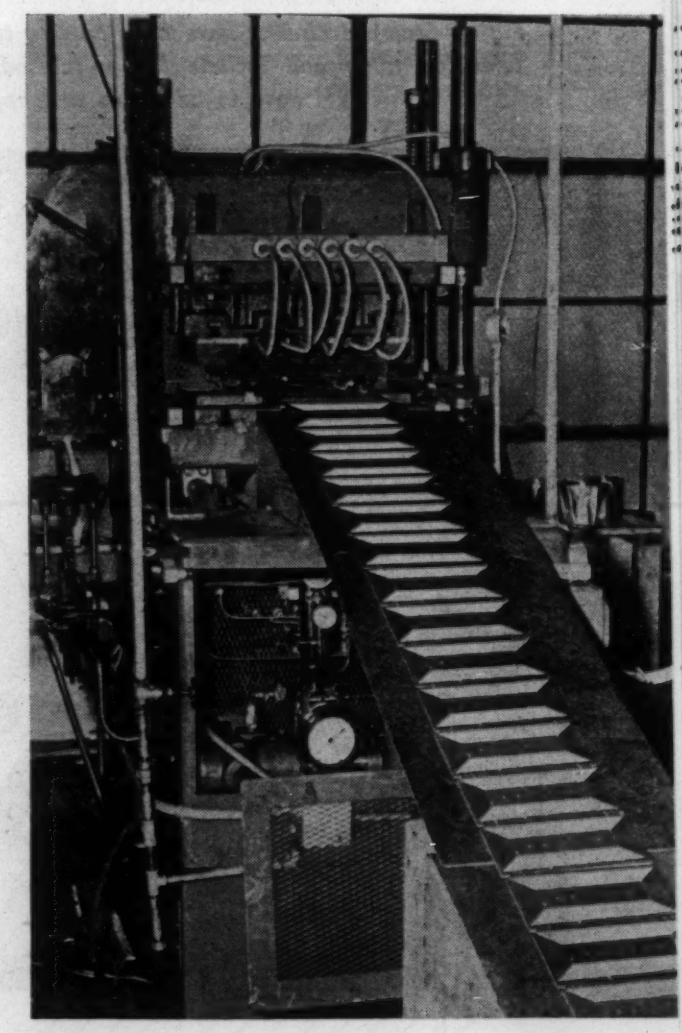


Fig 1—The table model radio receiver, at top, has the conventional maze of wires, whereas that below uses a panel provided with circuits stamped by the Franklin method.

Fig 2—A mechanically actuated press equipped with a heated die stamps circuits and at same time presses them into a Masonite panel.



to the panels. In one case, however, a tab was left protruding from a part of the circuit over the end of the panel. This tab was later folded over the edge of the panel, where a tongue thereon projected through a slot in a supporting metal housing and was subsequently soldered to the housing to provide a ground connection.

Panels are often pierced with holes for eyelets or other mechanical attachment of parts, such as electronic tube socket components, as in Fig 3. These then become either parts of the circuit or are insulated from it, as the particular requirements dictate.

Typical Applications

It is highly significant that stamped circuits are not confined merely to such conductors as might otherwise be built up from wires to form a harness or are merely a group of conductors. Parts of the stamped components often take the form of flat inductor coils, and they can also be made in a grid-like pattern to take the place of wound resistors. In either case, the coil or grid is fastened to the panel, takes up little room and is, if desired, already connected to other parts of the stamped circuit, and so avoids the extra expense of purchasing, handling and attaching separate coils or resistors.

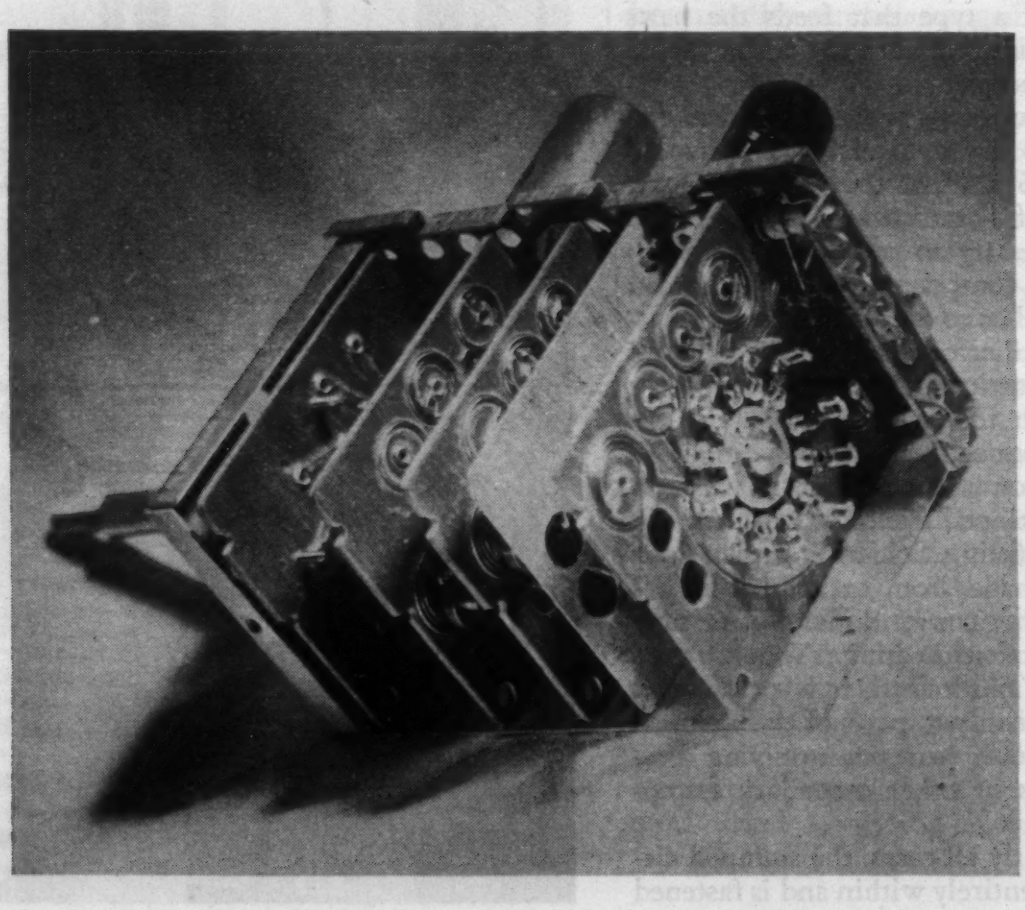
Advantage is taken of this possibility in all four panels in a tuner for television sets. Each of these panels, Fig 4, measures about 2¼ by 3 in., and they are set parallel to each other and spaced about 1 in. apart in a steel frame. A shaft runs through each panel and turns rotary switches, one located near the center of each panel. Fixed contacts of the switches are fastened to the panels by eyelets, some of which pass through parts of the stamped circuits applied to both sides of the panels. Parts of the circuits extend outward (more or less radially) to flat spiral inductor coils that have one to four turns and are produced at the same time as other parts of the stamped circuits.

On three of the four panels there are disk-headed self-tapping brass screws whose threaded shanks pass through holes in the panels. When the screws are turned, the distance of the disk from the coil is varied, thereby varying the inductance of the coil by a very simple and convenient means. Such a setup is far simpler and costs less than conventional panels in which helical coils would have to be mounted individually and soldered, after which the coils whose inductance must be varied are "picked" to spread them as required in adjusting the inductance.

In this tuner assembly, the remaining components are conventional (to meet purchaser requirements) and have to be wired to the panels and to the electronic tubes mounted on the housing. It would be possible, however, to make several additional components by Franklin stamping methods, thus avoiding much of the applied wiring, if the design had been completely adapted initially to the stamped method of fabrication.

By far the largest application of stamped circuits has been in the making of airloops, Fig 5, that are applied to Masonite or tag board panels of table and portable radios. Several million such loops are now in service and are giving a good account of themselves in radios of a large percentage of sets built in this country during the last two years. Such loops are merely flat spiral coils. In nearly all cases, these coils are oblong

Fig 4—Stamped circuits have been applied to both sides of these panels in the television tuner and include flat spiral inductor coils which otherwise would have to be wound and applied separately.



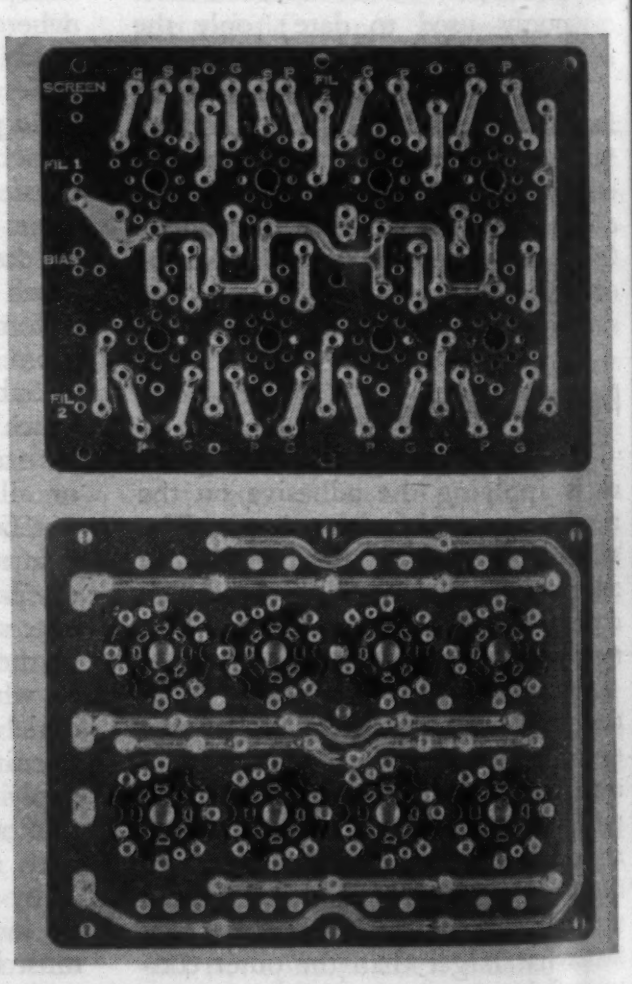


Fig 3—Front and rear views of Bakelite panel on both sides of which are circuits stamped from tinned copper. In lower view, tube bases have been applied; components are fastened with eyelets, some of which connect with stamped circuits on reverse side.

"spirals" because this shape adapts itself well to the panels needed and makes best use of space available.

Loops of this type are made by the same method as other stamped Franklin circuits but, instead of having individual conductors that lie flat against the panel, have conductors of V-shape transverse section. This is accomplished by using a die whose elements are V-shaped. When the die closes it slits the metal along the crest of each Vee and, with further motion, indents the panel. Some of the latter is forced upward to form ridges between the Vees of the die. The conductors adhere to the sides and crests of the ridges, as shown in Fig 6. As a result, the flat coil consists of a series of V-shaped conductors in the pattern desired.

When a die of this type is used, it is possible to make flat coils in which there are 30 conductors (or less, if preferred) per inch measuring parallel to the panel. There is, of course, an air space beween each turn, and this has led to the term "airloop". With 30 turns per inch, the space between them is small, but it can be increased as much as desired by decreasing the number of turns per inch. Even with close spacing there is ample insulation between turns for the applications involved.

Since the die used for making such loops slits the metal and then separates it between turns of the coil produced, there is no metal to be stripped away between turns unless spacing is wider than is commonly necessary. At the outside of the loop and in the open space at the center, metal is sheared and later is stripped off, just as for other circuits, and eyelets or pins are commonly applied at the ends of the coil or coils.

In some cases, taps are left so that products of the same die can be used for different connections in more than one model of radio. Franklin Airloop Corp. now has many stock or "standard" dies that can be used to supply any maker who can employ loops of the dimensions available, without incurring the cost of new stamping dies.

Another typical application is the electronic panel of a card punching machine, shown in Fig 3. This 6- by 8-in. panel is of laminated Bakelite 3/32 in. thick. There are stamped circuits of tinned copper on both sides. These include connections to eight tube sockets whose components are applied with eyelets. There are no crossovers on either face of the panel, but the circuits on one side cross over those on the opposite face at many points. In this instance, the panels are not only supplied with the stamped circuits but with tube bases and some other components.

Stamped conductors produced as described are not insulated on the outer face. If such insulation is needed, however, it is easily applied in the form of a varnish or enamel such as Insul-X, using roller, spray, dipping or brush methods, depending upon specific requirements. It is also possible to apply laminations of plastic, paper or other insulators that will cover whatever portions of the circuit may require such protection.

Clearly, application of the Franklin method promises to work more or less of a revolution through the production of inexpensive but dependable circuits of certain types. As it uses wrought metal of definite and uniform thickness, it has definite advantages over printed and sprayed circuits, none of which have yet seen commercial application on a scale comparable to that already attained by the Franklin method.

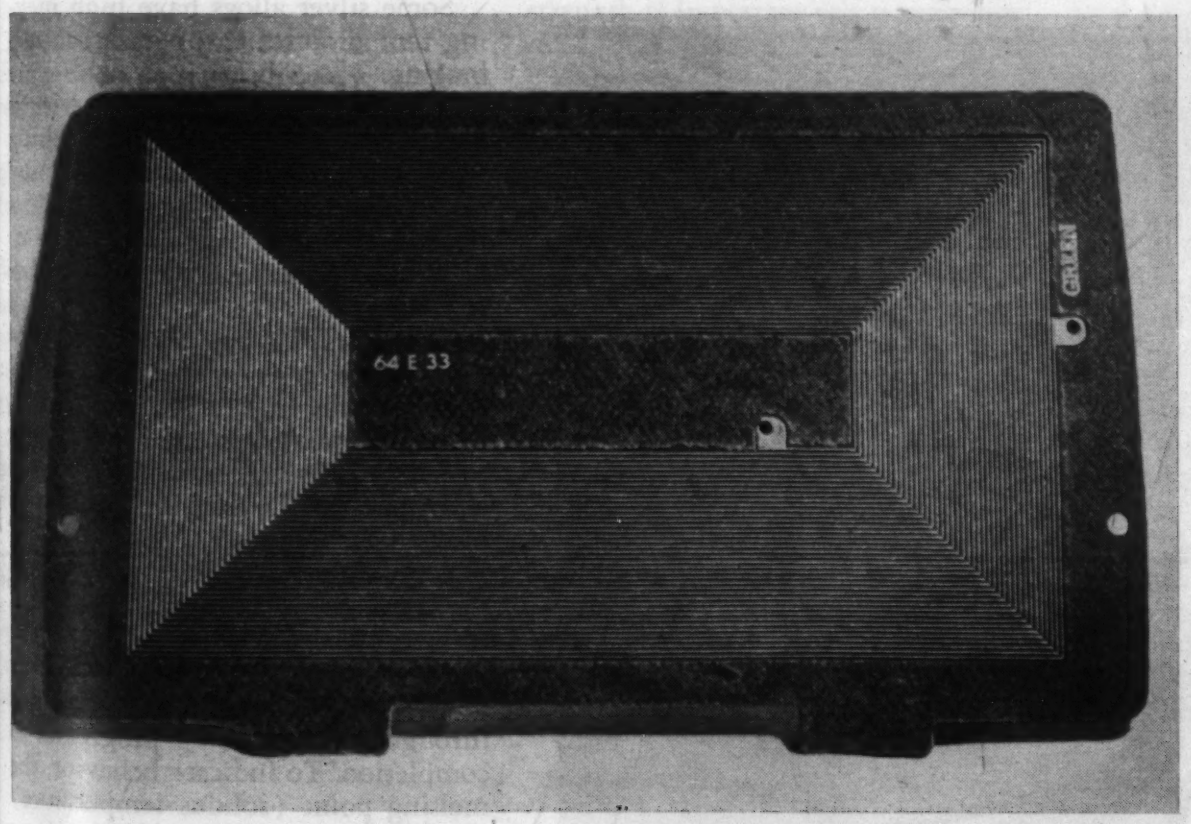


Fig 5—Airloop panel, the conductors of which are produced and applied by the Franklin stamping method. In many such panels 30 conductors per inch are produced.

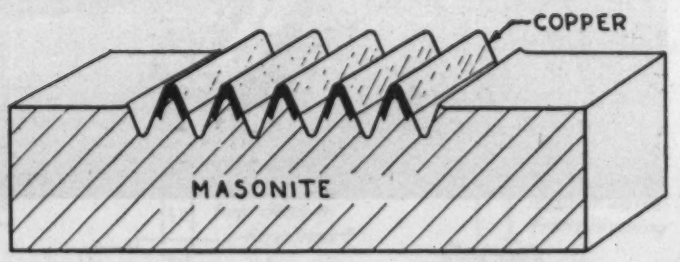


Fig 6—Section through an Airloop panel. V-shape portions of the die shear the metal and, with further motion, produce valleys in the Masonite panel.

Silver Alloy Brazing a Versatile Joining Method

Selection of the proper silver brazing alloy and flux from among the many available, and correct design procedures, assures high quality brazed joints.

by A. STANLEY CROSS, JR., Brazing Engineer, American Platinum Works

● SILVER ALLOY BRAZING, also known as silver soldering and hard soldering, is perhaps the most versatile of the brazing processes, covering as it does a variety of heating methods and being applicable to all the brazeable metals except aluminum and magnesium. The process employs silver alloys melting between 1100 F and 1600 F. Although higher in cost than some joining methods, where properly applied, the free-flow characteristics of the silver alloys and the low joining temperature will keep the total cost of the operation low.

Silver Brazing Alloys

About 20 silver brazing alloys are now considered standard. Melting temperatures range from 1125 to about 1600 F. The majority of these alloys are for special purposes, or are older compositions which are not used extensively today, and it is seldom necessary to choose between more than two or three for any job.

The brazing alloy must make a sound metallurgical bond with the base metal. It is also desirable to make this bond at a low temperature. On all brazeable metals except aluminum or magnesium, silver brazing alloys provide a good combination of these properties.

Some silver alloys have high melting temperatures to provide for step brazing. (Step brazing is done close to a joint made previously with a higher melting alloy, without melting the first joint.) The plastic or mushy stage found in melting some alloys permits the building of fillets or bridging gaps caused by poor fits between parts.

The cost of these alloys increases with the silver content. For some applications the lower silver alloys have poorer properties and the lowest cost per joint is usually obtained with the alloy having the brazing properties best suited to the job.

Some silver brazing alloys approach the eutectic composition, which transforms from the solid to the liquid state at one temperature. Other alloys have a temperature range through which melting progresses to completion. To indicate behavior, the melting point (solidus temperature) and flow point (liquidus temperature) are recorded; there has been some confusion in the past because manufacturers have not always differentiated between the two. The alloy and the work must be heated to at least flow temperature of alloy.

The four outlets are furnace brazed to the stainless steel lid at the right, with 0.005-in. preplaced strips. The other two parts are torch brazed with the same silver alloy.

Silver alloys are supplied in rod, wire, coils, sheet, strip or special forms, such as rings, washers, formed wire shapes, extruded shapes, disks, slugs and powder. In recent years the advantages of preplaced alloy have become more apparent and the use of special forms has been increasing. Many mechanized operations are made possible only by the ingenious use of special forms. Even hand brazing operations are done easier and faster with preplaced alloy.

Fluxes

Suitable fluxing agents clean surfaces for silver brazing. When joining copper with the silver-copper-phosphorus alloy (Alloy F) excellent results can be obtained without flux, but experience has shown that even with this combination better results can be obtained if a flux is used.

Paste fluxes consisting of a mixture of fluoride and borate salts are most common. The brazing flux melts before the alloy forming a coat of fused salts over the brazing area. This fused salt must be stable for the time and temperatures used in the operation.

The flux has three functions:

1. To prevent oxidation of the surface during heating, brazing and cooling.
2. To clean, reduce, dissolve or float off dirt of oxides present on the work of the brazing alloy.
3. To reduce the surface tension of the molten alloy, causing it to flow freely over the work surfaces.

Silver brazing fluxes contain a toxic fluoride salt and should not be taken internally, and fumes driven from the work during heating and unnecessary contact with the flux paste should be avoided. Experienced brazing operators working in open areas are seldom bothered by the toxic qualities of the flux, however.

Base Metals

The base metal or metals being joined must be considered, and in some cases certain precautions taken to obtain the best results. Since silver brazing is used on many metals, a variety of problems is likely to be encountered.

Copper—The good heat conduction and high specific heat of this metal may cause some difficulty when brazing heavy sections. All silver alloys "wet" or alloy with copper well. The silver-copper-phosphorus alloy (Alloy F) has an advantage on some applications because the use of flux is unnecessary. On stranded electrical cables, for example, complete flux removal is impossible.

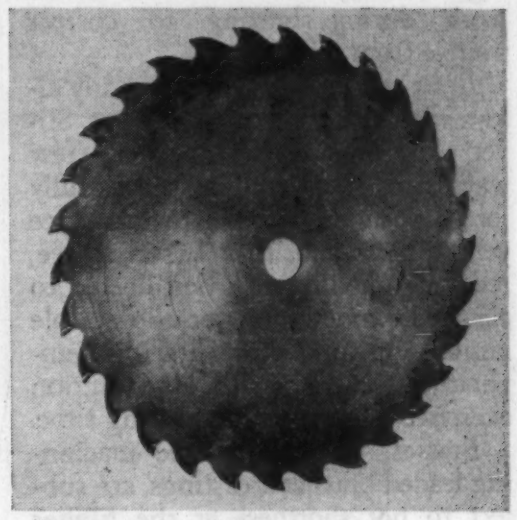
When oxygen-bearing copper, including the common tough pitch grade, is heated in a reducing atmosphere, especially hydrogen, the oxygen in the copper may combine with the atmosphere. The gases formed weaken the copper by forcing their escape to the surface. This may occur during brazing, especially by the hydrogen atmosphere furnace method. It takes place mainly on the surface and is most serious on thin sections. The temperature and heating time influence the extent of the reaction. Oxygen-free copper should be specified for reducing atmosphere brazing to avoid this embrittlement.

Cold worked copper will be annealed by brazing temperatures. When strength is important this temper loss must be considered.

Steel and Iron—Carbon steel and alloy steels are readily brazed with silver alloys, although steel is not wetted by all alloys. Alloys for brazing steel should have an appreciable percentage of zinc, cadmium, tin or nickel to alloy with the steel. Most alloys with 60% or more silver do not wet steel well and are not recommended. Phosphorus alloys make very brittle unsatisfactory joints on ferrous metals.

The low temperatures of silver brazing permit the joining of heat treated steel. However, there may be some influence on the properties, and on vital applications the effect of the brazing temperatures should not be disregarded.

Cast iron cannot be brazed successfully in a production operation without proper preparation. Electrolytic cleaning is the best way to remove the carbon, which interferes with silver brazing, from the surface of cast iron. Cast iron is then brazed with the same alloys recommended for steel.



Silver brazing alloy holds the tungsten carbide cutting teeth on a circular saw.

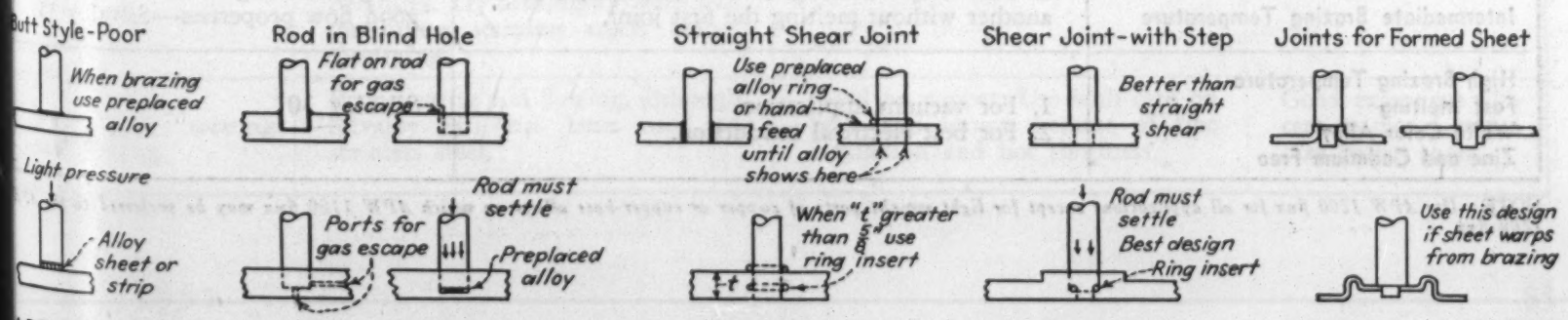
Stainless steels are joined extensively by silver brazing. The same brazing alloys recommended for steel are used although the higher silver alloys are applied with somewhat better results. Stainless steels must be heated carefully to prevent over-heating of local areas. The low thermal conductivity and high thermal expansion of some steels might also cause distortion if heating is localized.

Two problems likely to be encountered are:

1. Reduction of corrosion resistance through carbide precipitation: Stainless steels in the 300 series when heated above 800 F precipitate chromium carbide, reducing corrosion resistance. The use of low-carbon steels and low brazing temperatures with rapid heating will minimize this effect. Stabilized stainless steels are silver brazed without trouble.

2. Intergranular attack by the brazing alloy: The cause of the penetration of brazing alloys into stainless steels is not fully understood. Other brazing metals (especially brass) attack the stainless to a greater

Some joints for brazing a rod to a plate.


Butt Style-Poor
When brazing use preplaced alloy
Light pressure
Alloy sheet or strip
Rod in Blind Hole
Flat on rod for gas escape
Ports for gas escape
Rod must settle
Preplaced alloy
Straight Shear Joint
Use preplaced alloy ring or hand feed until alloy shows here
When "t" greater than 5/8" use ring insert
t
Shear Joint-with Step
Better than straight shear
Rod must settle
Best design
Ring insert
Joints for Formed Sheet
Use this design if sheet warps from brazing

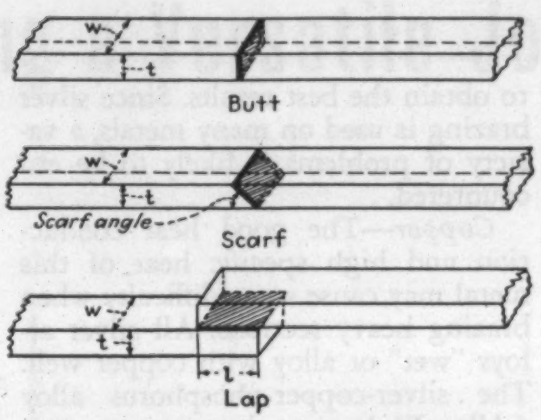
degree than silver alloys. Use low brazing temperatures with short heating times and eliminate stress in the work during brazing to correct trouble from this cause.

Brass and Bronze—Brass readily alloys with all silver brazing alloys. Silver alloy brazing is one of the few ways that brass can be successfully joined to itself or other metals since yellow brass and, to a lesser degree, red brass distill zinc when heated to elevated temperatures for appreciable periods of time. Low brazing temperature should be used and caution exercised against a long heating time.

Brasses, particularly free machining leaded brass and castings, are subject to hot shortness at the higher brazing temperatures. Use the lowest temperature silver brazing alloy, eliminate all stresses in the base metal, and avoid setting up thermal stresses during brazing.

Bronzes are readily brazed with silver alloys, although aluminum bronze may require a special flux. Hot shortness is the primary source of trouble. When brazing bronze, use low brazing temperatures, eliminate stresses in the parts, and avoid setting up thermal stresses during heating.

Monel may also be hot short at brazing temperatures and is subject to intergranular penetration by the brazing alloy in stressed sections. Low brazing temperatures and freedom from stresses during brazing are recommended.



Basic joint designs for silver brazing.

Joint Design

The brazing alloy and the base metal joined influence the strength of the final assembly. Although there are differences in strength between the various silver alloys, these differences are of minor importance to the final joint strength. The best overall results are obtained from the alloy which has the best brazing properties with the base metal being joined.

On the other hand, the base metals being joined have an important influence on the strength of the joint. In a joint on high strength metals the alloy film in the joint will test stronger than the alloy itself. The rigidity of the joint confines the alloy film, giving it properties different from those of the alloy itself. Thus, identical joints have greater strength on high strength metals than on metals with lower strength.

Two design factors influence the strength of the complete joint:

1. *Type of Joint and Its Area*—Different joints subject the alloy film to different stresses, altering its behavior under stress. The stress on a joint will be either: (a) tension in a butt joint, (b) tension or shear in a scarf joint, or (c) shear in a lap joint.

The strength of a butt design can, under the best conditions, approach the strength of the metal joined. The joint will fail after the base metal yields and the stress on the alloy becomes complicated by dimension changes in the yielding parts. Butt joints are limited to the cross section area of the part, and there is no allowance for defects in the braze. The butt joint is also difficult to support and position during brazing, and should be avoided if possible.

The scarf joint is an improvement since the joint area may be increased by changing the angle of scarfing. It is little used, however, because of the expense and difficulties involved in preparation and positioning of the parts.

Chart for Selection of Silver Brazing Alloy

Properties Desired in the Brazing Alloy	Typical Applications	Recommended Alloy (See Note for Fluxes)
Higher Brazing Temperature	1. For joints subject to elevated service temperatures. 2. For "step" brazing of one joint adjacent to another without melting the first joint. 3. For brazing and heat treating in one operation at the indicated temperatures.	Silvaloy A4 Silvaloy All Silvaloy 250
Flux Free Brazing of Copper Intermediate Brazing Temperature Slow Melting	1. For copper equipment where flux residue is harmful or where moisture from the flux must be avoided. 2. Where fillets are required on copper-base alloys.	Silvaloy 15
Low Brazing Temperature Free Flowing Fast Melting	1. For lowest labor cost for well designed joint. 2. To minimize heat effect on the base metal. 3. For best results with pre-placed alloy by hand or mechanized heating methods.	Silvaloy 45—lowest temp. Silvaloy 50—U. S. Gov't. Grade 4 Silvaloy 40—lower cost Silvaloy 355—whitish color, cadmium free
Slow Melting Intermediate Brazing Temperature	1. For bridging gaps or building fillets. 2. For "step" brazing of one joint adjacent to another without melting the first joint.	For longest plastic range—Silvaloy 503 For plastic range with good flow properties—Silvaloy 35
High Brazing Temperature Fast Melting White Color Alloy Zinc and Cadmium Free	1. For vacuum application. 2. For best electrical conduction.	Silvaloy 301

NOTE: *Use APW 1200 flux for all applications except for light weight parts of copper or copper-base alloys on which APW 1100 flux may be preferred to the APW 1200 flux.*

The majority of joints in use are lap designs. With this type parts can be self-jigging and easily positioned for brazing. Preplaced alloy is readily used and the designer may increase the lap length to obtain a strong braze. For purposes of calculation, the alloy film in a lap joint may be assumed to have a shear strength of 30,000 psi.

2. *Clearance Between Members of Joint*—The clearance between members determines the thickness of the alloy film between the parts. If maximum strength is to be obtained, clearance in the joint must be large enough to permit entry of the molten alloy and escape of the molten flux and gases developed during heating. If too large a clearance is used, the alloy will not be held in the joint by capillary attraction and the joint will have to be filled by puttying of the alloy in its plastic state.

Ideal clearances are 0.001 to 0.003 in., while joints with clearances up to 0.006 or 0.008 in. are good. Clearances below 0.001 and above 0.008 in. should be avoided if possible, not only because of poorer strength of the joint, but also because of the expense of making such joints. Clearances below 0.001 require expensive machining to close tolerances, and large clearances require care to braze and an excessive amount of silver alloy to fill.

When determining clearances for parts of dissimilar metals, the thermal expansion of the parts must be considered and sufficient clearance allowed at brazing temperature for entrance of the alloy.

Vibration stresses may be important. The geometry of the parts and the design of the joint influence the strength of any assembly in vibration. Actual tests are recommended. Joints subject to vibration should be lap designs, made with recommended clearances by the best brazing techniques. If possible, locate the joint out of critically stressed sections and guard against stress concentrations that are caused by abrupt changes in section.

Specification List for Silver Brazing Alloys

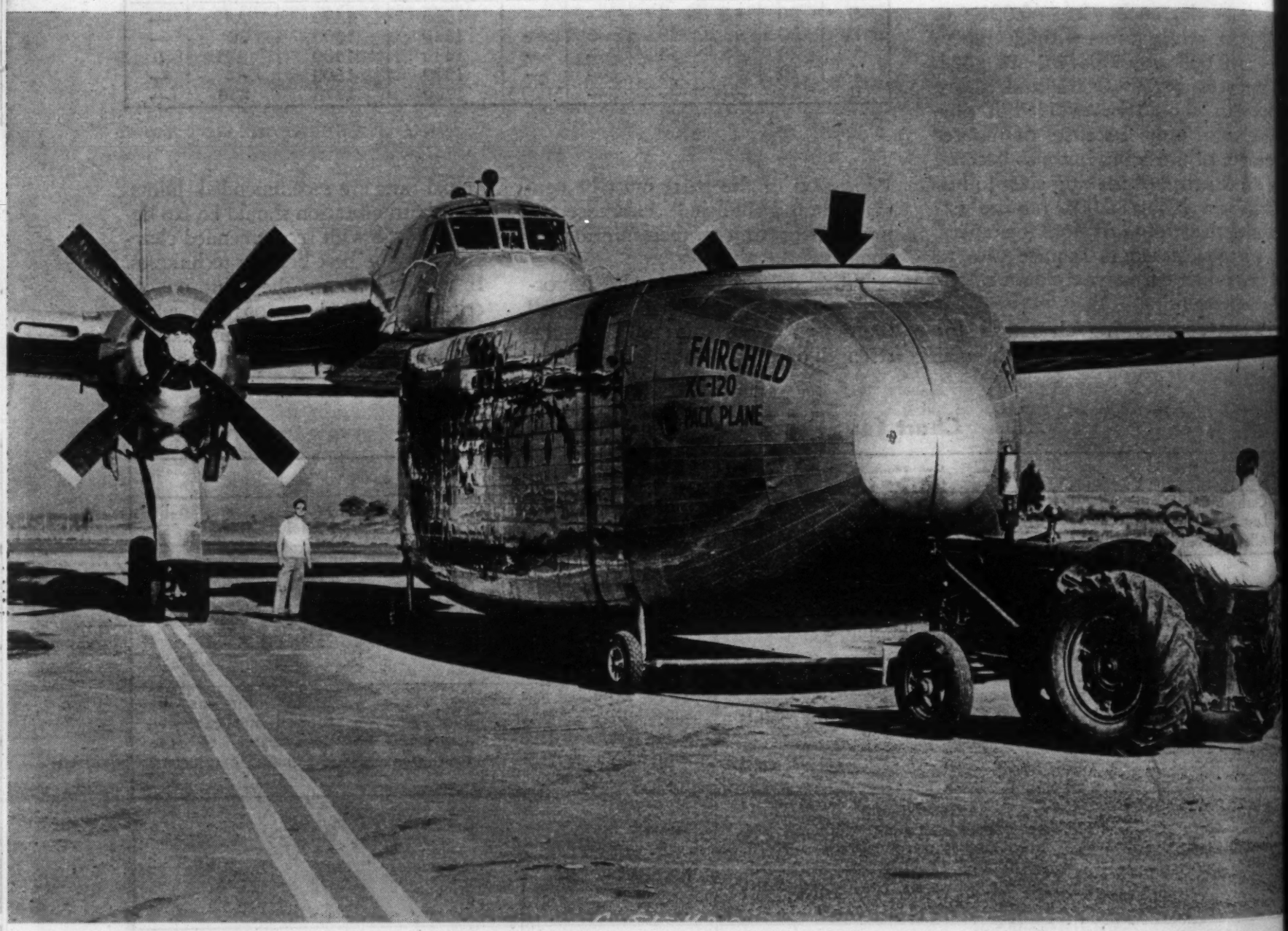
Alloy	Ag	Cu	Zn	Cd	Others	Melting Range, F		Com. Desig. Silvaloy No.	Fed. Gov't Agencies Fed. Spec. QQ-S-561d
						Liquidus	Solidus		
A	45	15	16	24	—	1125	1145	45	—
B	50	15.5	16.5	18	—	1160	1175	50	4
C	56	22	17	—	Sn-5	1152	1203	355	—
D	40	18	15	27	—	1135	1205	40	—
E	50	15.5	15.5	16	Ni-3	1195	1270	503	5
F	15	80	—	—	P-5	1185	1280	15	3
G	35	26	21	18	—	1125	1295	35	—
H	60	25	15	—	—	1260	1325	A33	—
I	65	20	15	—	—	1280	1325	Easy	2
J	50	28	22	—	—	1250	1340	A28	—
K	45	30	25	—	—	1250	1370	A18	1
L	30	38	32	—	—	1370	1410	A13	—
M	40	30	28	—	Ni-2	1222	1416	250	—
N	50	34	16	—	—	1272	1425	A25	—
O	72	28	—	—	—	1435	1435	301	—
P	40	36	24	—	—	1330	1445	A14	—
Q	80	16	4	—	—	1360	1490	A49	—
R	20	45	30	5	—	1140	1500	20	—
S	20	45	35	—	—	1430	1500	A11	0
T	10	52	38	—	—	1510	1600	A4	—
U	85	—	—	—	Mn-15	1760	1778	850	—

Chart for Selection of Silver Brazing Alloy

Base Metals to Be Joined			
Carbon Steel Low Carbon Steel Alloy Steel	Stainless Steel	Copper Brass Bronze	Nickel Monel Nickel Silver
Good	Good for those stainless steels whose corrosion resistance is not harmed by the brazing temperatures. Try free machining steels before specifying.	Good on copper. Use with care against zinc distillation on brass or hot shortness in brass and bronze.	Good, except use with care on monel which, may be hot short.
Must not be used, brittle joints are formed.	Must not be used, brittle joints are formed.	Good for hand fed alloy or where alloy sheet is located in an area joint. Preformed rings, etc. are recommended only where heating is rapid or ring is enclosed.	Brittle joints may be formed and excessive penetration of the base metal may occur.
Good	Good, although on unstabilized steels care must be taken to prevent lowering of corrosion resistance. Try brazing job with free machining steels before specifying for production.	Good	Good
Good	Good for those stainless steels which are not harmed by the temperatures. Try brazing job with free machining stainless steels before specifying.	Good	Good
Very poor wetting and flowing.	Poor wetting and flowing, although Silvaloy 301 has been used on stainless steel.	Good on copper. Use with care on brass and bronze because of zinc distillation and hot shortness.	Good, except use with care on monel, which may be hot short.

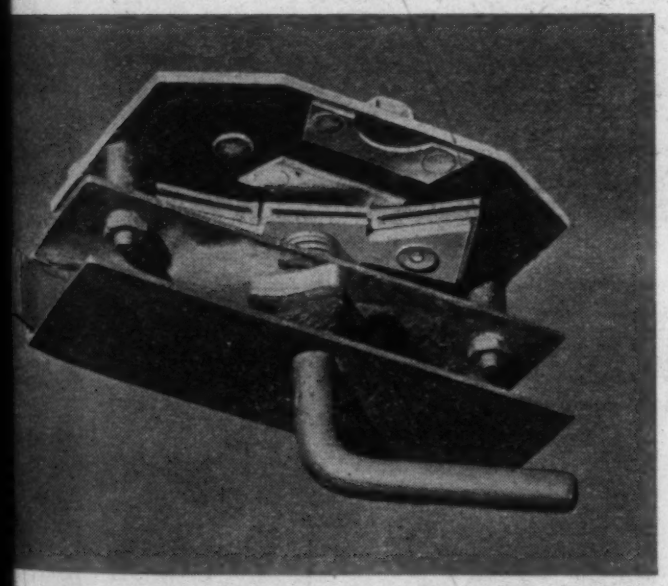
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



RUBBER SEAL *Ordinary inflated seals and compression seals could not be used to close the 2-in. space between the cargo pack and the fuselage of the Fairchild packplane since they put a 3½-ton separating force on the plane and were damaged in positioning the pack for attachment. Engineers of the B. F. Goodrich Co. designed a weather seal, with an inflatable tube, made of rubberized fabric with a soft rubber base. A rubber strip was cured to the top of the tube to make a lip-type seal, which was attached to the pack. Deflated height of the tube, only ⅜ in., allows clearance during attachment of the pack. It inflates to 8½ times this height to form an airtight seal. The soft rubber lip practically eliminates separating force.*

PRESSURE SPHERE *A spherical pressure vessel to contain liquid nitrogen at 5,500 psi at —350 F was fabricated by Research Welding and Engineering in California for U. S. Air Force rocket experiments. The sphere measures 54 in. in dia and weighs 7,500 lb. Six 3.687-in. plates, rolled as a special lot from 347 ASTM-A240 Grade C stock, were pressed at 1700 F to 22.500 in. spherical radius by the National Supply Co. After flame trimming, grinding and pickling, the first passes were made with Heliarc welding. These welds were then subjected to both gamma rays and Dy-Chek penetrant inspection before the joints were filled by multiple-pass arc welding. Nearly a ton of coated electrode metallic arc rod was used.*



INSULATING PLATE *Frequent d.c. arcing is a challenge to any insulating material. Conventional insulating material tends to develop deep, permanent carbon-tracking under those conditions, resulting in short-circuiting of current and eventual disintegration of the material. In designing a reversing switch for their 120-v d.c. welding generators, Lincoln Electric solved the problem with Glastic, a Fiberglas-polyester made by Laminated Plastic, Inc., of Cleveland. Design economy called for a flat-sheet insulating switch-plate into which contactors could be riveted. In use, the switch is repeatedly thrown against the full current load, giving arcing close to the insulating surface. The arc-resistance of Glastic was found to be nearly equal to that of glass-melamine, and the price was considerably lower.*

RE-ENFORCED PLASTIC INSULATOR *Conductor bar insulators used in the overhead materials-handling systems of the Cleveland Tramrail Div. of the Cleveland Crane and Engineering Co. are now being molded by Laminated Plastics, Inc., of Fiberglas re-enforced polyester resin. When the part was made of Phenolic, two metal inserts were required for strength, although the danger of short-circuiting was increased by the proximity of the metal pieces, and hairline cracks from molding heat often caused them to loosen. Loose inserts lead to short-circuiting by allowing moisture and fumes to seep into the cracks. The insulators are made much stronger than the 6-lb dead weight carried would require in order to support careless steps of maintenance men walking along the overhead tracks.*

Materials at Work

STAINLESS STEEL TUBE

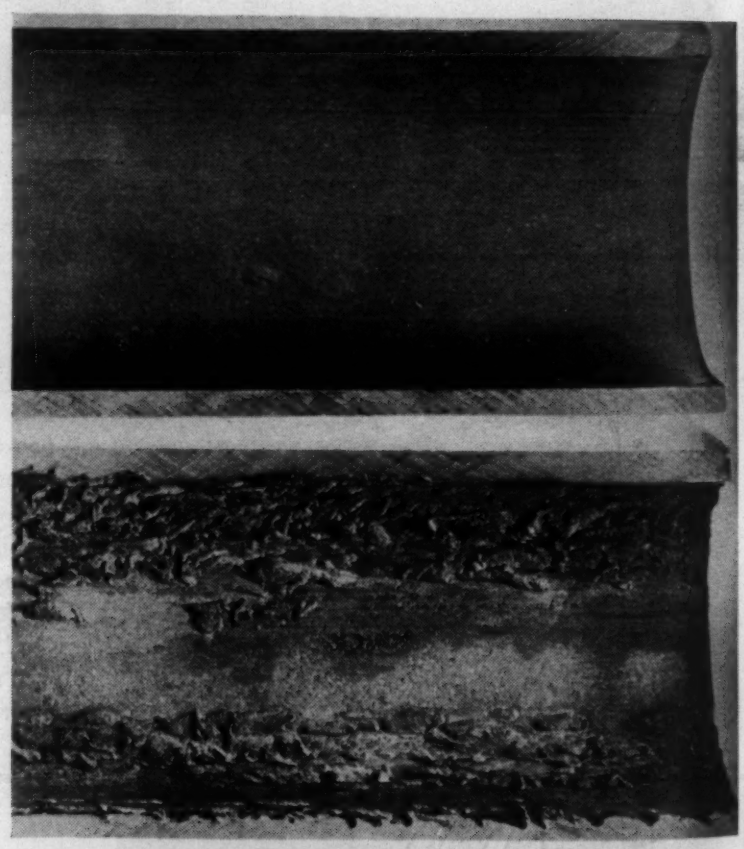
A new stainless steel developed by the Carnegie-Illinois Steel Corp. for the Radio Corp. of America makes possible commercial manufacture of a larger, lower-cost, light-weight rectangular television tube that is easier to manufacture and more durable than previous models. The new steel is easy to form, strong enough to withstand the pressures caused by the vacuum inside the tube, and, most important of all, has substantially the same rate of heat expansion as glass so that the glass is not cracked during the sealing operation. A disk of the metal is spun into a round envelope from which the rectangular tube is produced; the envelope acts as a spacer between the cathode-ray assembly and the glass screen on which the image appears.

LIGHTWEIGHT SERVICE AUTOMATIC

A forged aluminum alloy receiver for the Colt 45 caliber service automatic cuts the weight from 39 to 26.5 oz, a reduction of 40%. The receiver is forged with aluminum, as it was with the heat treated AISI carbon steel formerly used, in order to position the fiber of the metal for maximum strength at the critical points where the recoil impact is concentrated. The energy which must be absorbed by the recoiling parts and the receiver is equal to the impact of a sledge hammer traveling 60 mph. The weight reduction with the aluminum alloy receiver improves marksmanship and decreases fatigue. The forged aluminum blank is shown between a steel blank and a finished steel receiver.

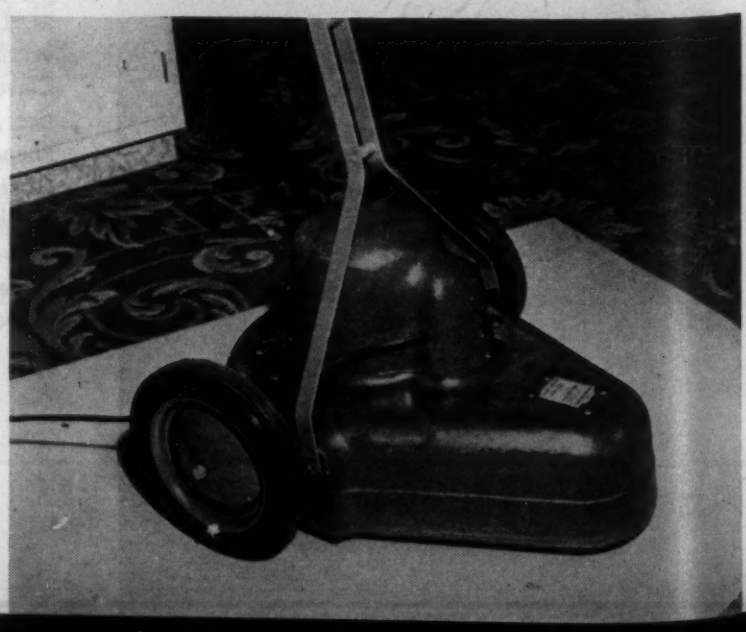
PLASTIC PIPE COATING

A six-coat finish based on Vinylite resins is applied to the inside of oil well pipe by the Liquid Plastics Co. to resist corrosion by salt water with high iodine content. A piece of untreated pipe that was exposed to the same service for five months was corroded as deeply as one-quarter of an in. in spots; treated pipe showed no measurable wear or attack in the same time. To apply the system, the inside of the pipe is sandblasted down to gray steel by a special nozzle, and a 360-deg spray lays on a primer coat, followed by five alternate red and black finish coats. The six-coat system, produced by the Plastic Coating Corp., is about 0.005 in. thick.



GLASS-AND-PLASTICS LAMINATE

Housings of glass-and-plastics laminate have replaced aluminum in a power lawnmower sold by Rumsey Distributors, and the change has made possible a substantial price reduction. Disk wheels are now made of the laminate also. The resulting lawnmower is 25% lighter in weight, saving on both shipping costs for the finished implement and delivery costs on the housings and disk wheels. Die costs have been cut to a small fraction of the original, production rate on the assembled pieces has been doubled, while floor space required has been cut to one-tenth the former figure, and painting has been eliminated.



Part 2 — Three-Dimensional Photoelasticity

Photoelastic Stress Analysis Useful in Design of Metal Parts

by M. M. LEVEN, Westinghouse Research Laboratory, Westinghouse Electric Corp.

The relatively new "frozen stress" technique described here is ideal where it is difficult to use other methods of experimental stress analysis.

• RECENTLY PHOTOELASTICITY has been extended to three-dimensional analysis chiefly by the method of "stress freezing" and slicing. Essentially, this method consists of preparing a three-dimensional model and loading it in a manner similar to that of the prototype. The temperature is then raised to a certain value, known as the critical temperature, and slowly lowered to room temperature with the loads acting. At room temperature the loads can be removed and a system of strains remains fixed in the model. It has been shown that these fixed or frozen strains represent an elastic state of stress. The model can then be cut into suitable slices without disturbing the fixed strains, and the stresses can be determined in the slices, as in two-dimensional photoelasticity.

The freezing and slicing method is particularly suited for the study of stresses in models containing sections of symmetry, such as the poppet valve model shown in Fig 11. Fig 12 shows the stress pattern obtained from the central longitudinal slice of the valve model from which the major principal stresses on the valve surface can be obtained. It is interesting to compare this pattern with that of Fig 1

Fig 11—Sketch showing method of loading Fosterite model of a poppet valve.

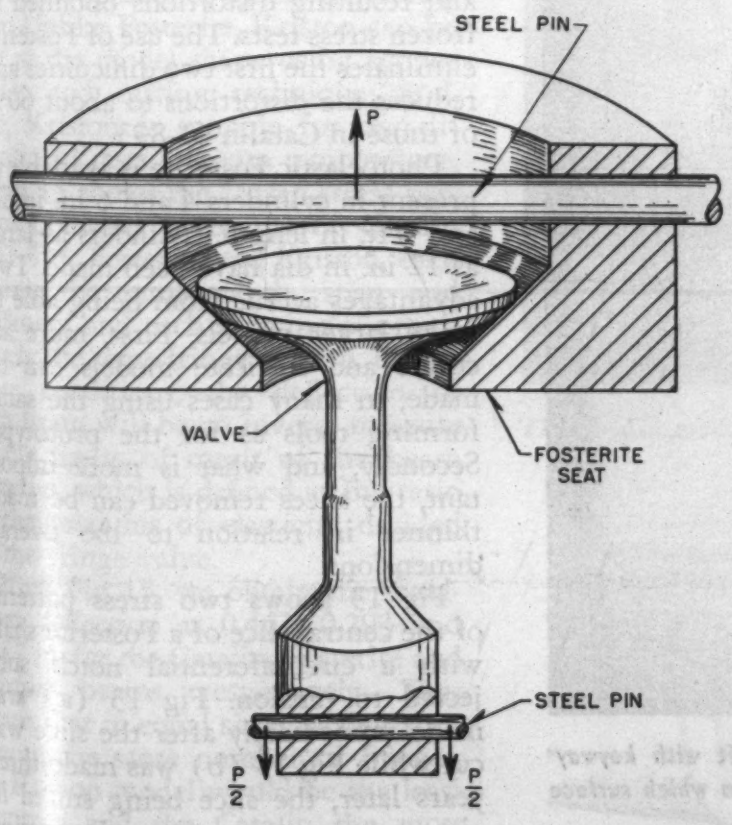
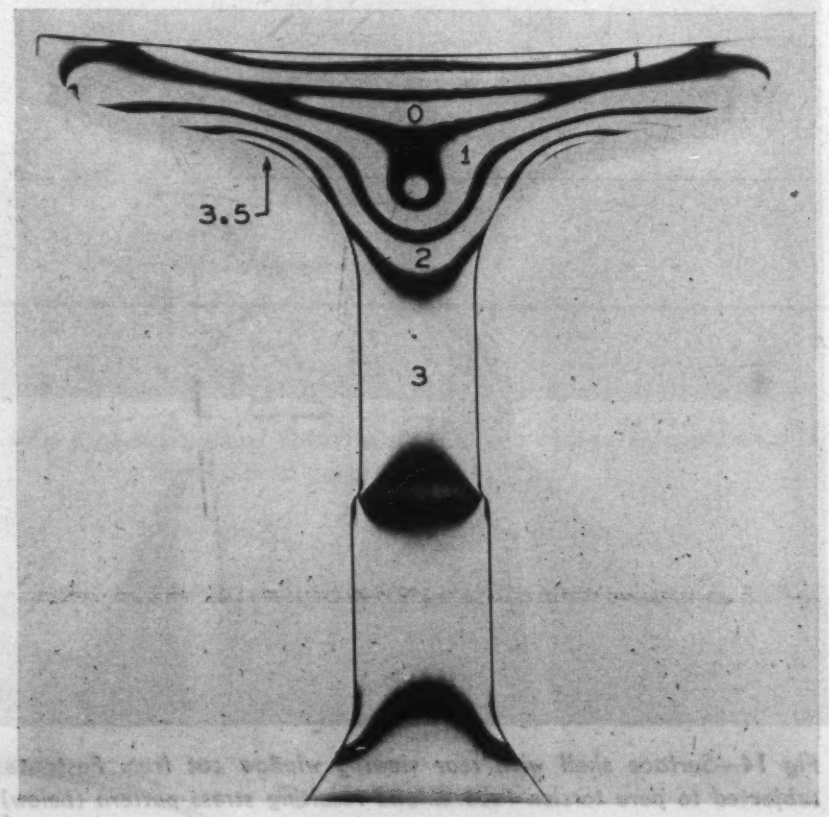


Fig 12—Stress pattern from central slice of flat-head poppet valve.



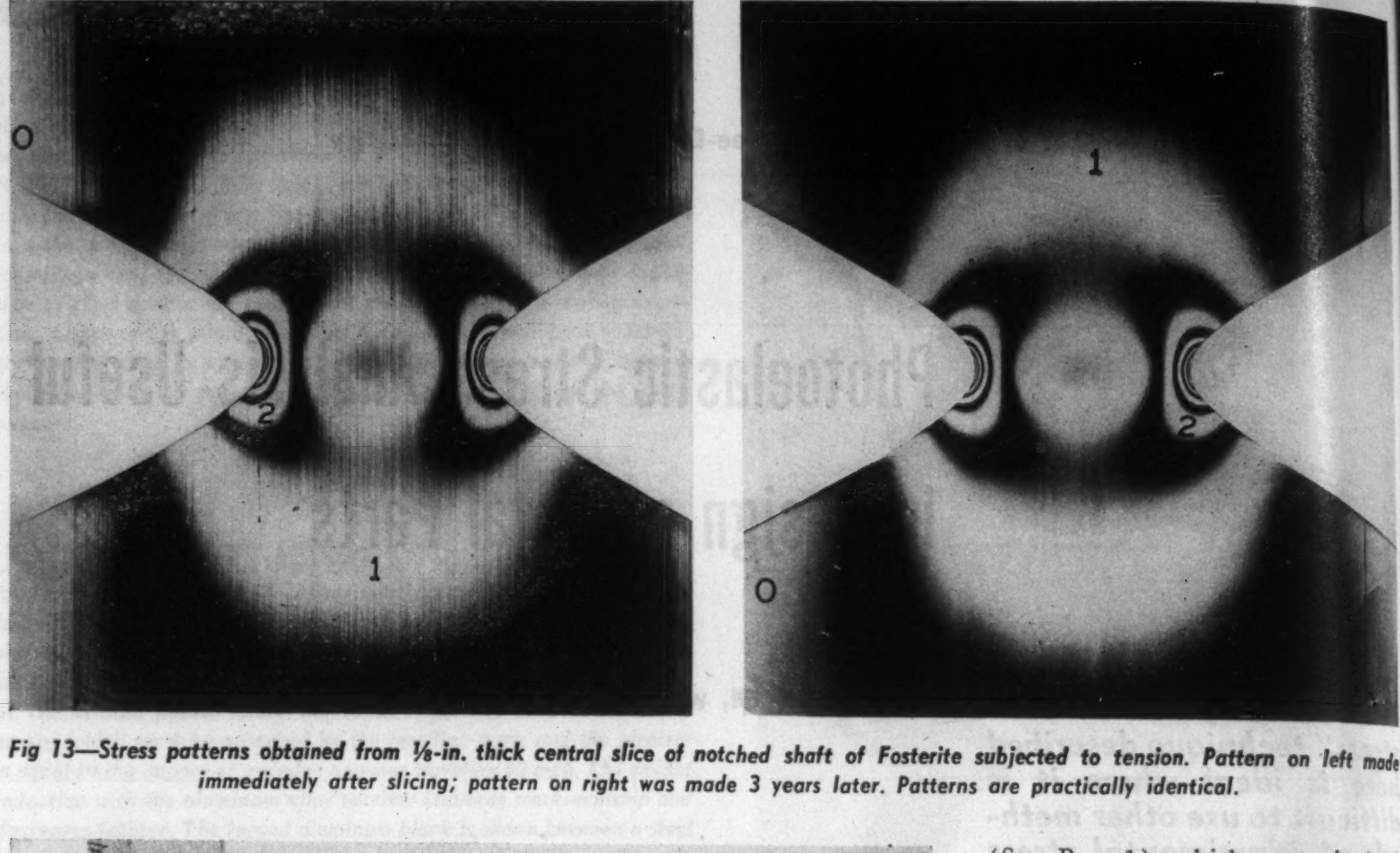
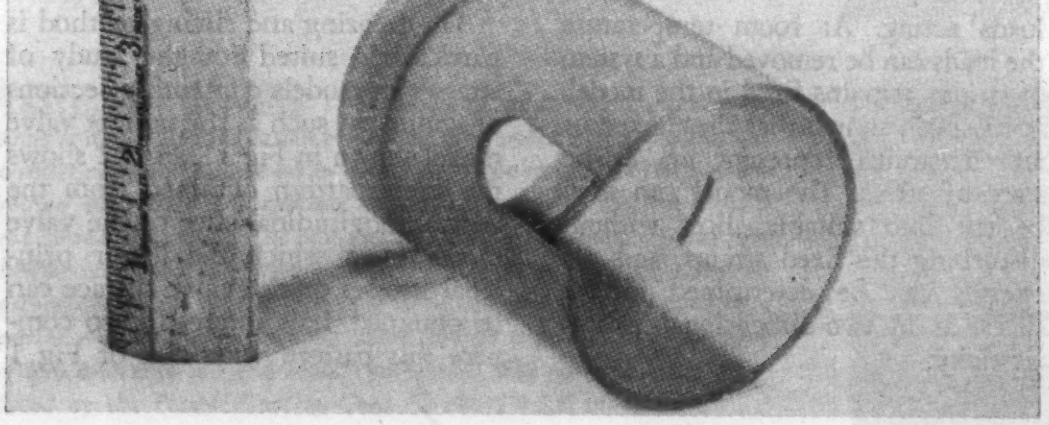


Fig 13—Stress patterns obtained from ⅛-in. thick central slice of notched shaft of Fosterite subjected to tension. Pattern on left made immediately after slicing; pattern on right was made 3 years later. Patterns are practically identical.



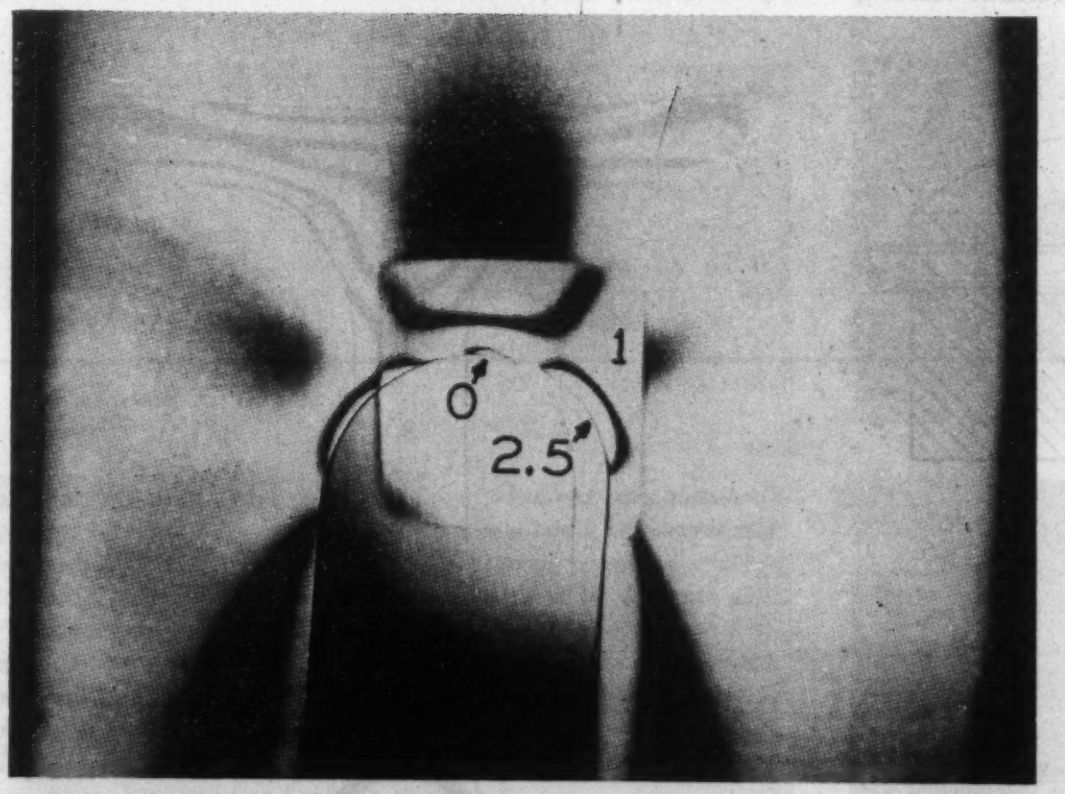


Fig 14—Surface shell with rear viewing window cut from Fosterite shaft with keyway subjected to pure torsion (above) and resulting stress pattern (below) from which surface stresses at keyway end can be obtained.

(See Part 1) which was obtained from a flat model of similar shape.

Materials

In 1947 Westinghouse introduced a styrene-alkyd resin, known as photoelastic Fosterite, which was far superior to Catalin C-61-893, which has three serious limitations for frozen stress tests. First is the size limitation, Catalin being available in plates of maximum thickness about 1 in. The second limitation is the formation of large time edge-effect stresses. These time stresses are much more serious in frozen stress tests than in ordinary tests because of the necessary longer times involved. The third limitation arises from the large deformations and resulting distortions obtained in frozen stress tests. The use of Fosterite eliminates the first two difficulties and reduces the distortions to about 60% of those in Catalin 61-893.

Photoelastic Fosterite is available at present in cylinders 4 and 6 in. in dia and 3 ft. in length. Cylinders as large as 12 in. in dia have been made. Two advantages accrue from being able to make larger models. First, more accurate and intricate models can be made, in many cases using the same forming tools as for the prototype. Secondly, and what is more important, the slices removed can be made thinner in relation to the overall dimensions.

Fig 13 shows two stress patterns of the central slice of a Fosterite shaft with a circumferential notch subjected to tension. Fig 13 (a) was made immediately after the slice was cut while Fig 13 (b) was made three years later, the slice being stored in air at room temperature. Inspection

of the two patterns shows that practically no time stresses are formed in the stress freezing process not in the succeeding time interval of three years. Fig 13 also shows that there is no tendency for the frozen stress pattern to change with time when using Fosterite.

Due to the complete absence of time stresses in Fosterite and due to the large size models which can be made, it is possible to obtain the surface stresses in a generally stressed three-dimensional model by cutting off a thin surface layer or rind and obtaining the stresses in this layer by means of the polariscope. Due to the concentration of time stresses on the surface, this method would lead to serious errors in Catalin models.

Fig 14 shows the surface shell cut from a Fosterite shaft with a keyway subjected to torsion and the resulting stress pattern. The maximum tension and compression on the shaft surface at the keyway end were found to be about 3.3 times as large as the nominal shear stress computed by the well known torsion formula

$$V = 16T / \pi D^3.$$

Kriston, an allyl ester monomer made by the B. F. Goodrich Chemical Co., was introduced in 1948 as a photoelastic material for three-dimensional tests. It has many advantages but suffers from one serious defect, namely, its poor machinability. It is exceedingly brittle and great care must be taken in machining it to prevent chipping and cracking.

Kriston is not available in plates or cylinders but must be cast from the liquid monomer by the individual user. Unlike Fosterite, Kriston can be cast to the model shape using proper molds and casting technique; and, also, Kriston is suitable for two-dimensional tests at room temperature.

Fig 15 shows the frozen stress patterns obtained in beams of Catalin C-61-893, Fosterite and Kriston, each having the same depth, span and thickness, and each showing approximately the same fringe pattern. Under these conditions, the deflection of each beam will be an inverse measure of the figure of merit of the beam material, which is defined as the ratio of the modulus of elasticity divided by the fringe value.

From Fig 15, we obtain the maximum deflection as 0.461, 0.293 and 0.117 in. for the Catalin, Fosterite and Kriston beams, respectively. This means that in equal sized models containing the same number of fringes, the Kriston model would be the least distorted and the Catalin the most

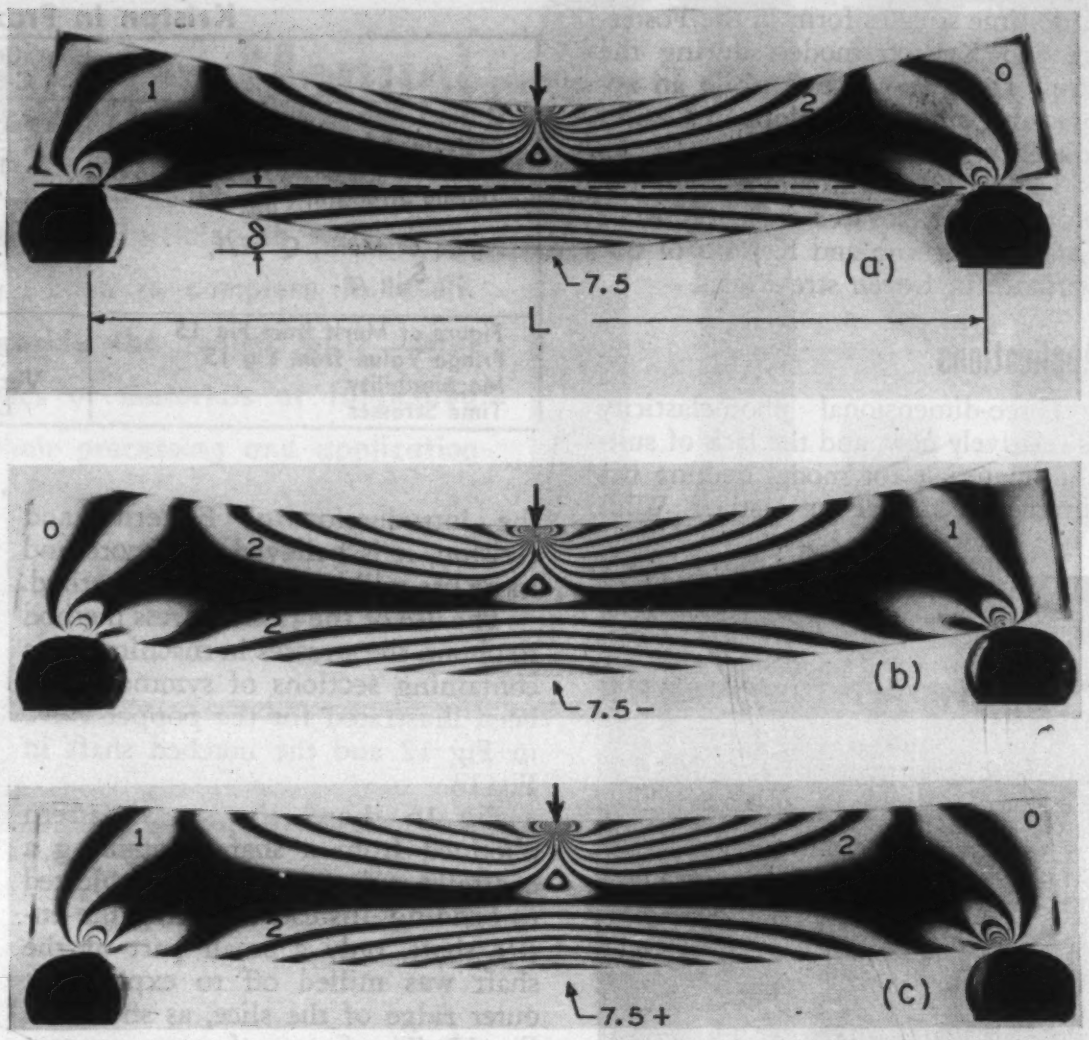


Fig 15—Centrally loaded, simply supported beams of (a) Catalin C-61-893, (b) Fosterite, and (c) Kriston showing maximum deflection for approximately similar stress patterns in beams of the same depth, thickness and length of span.

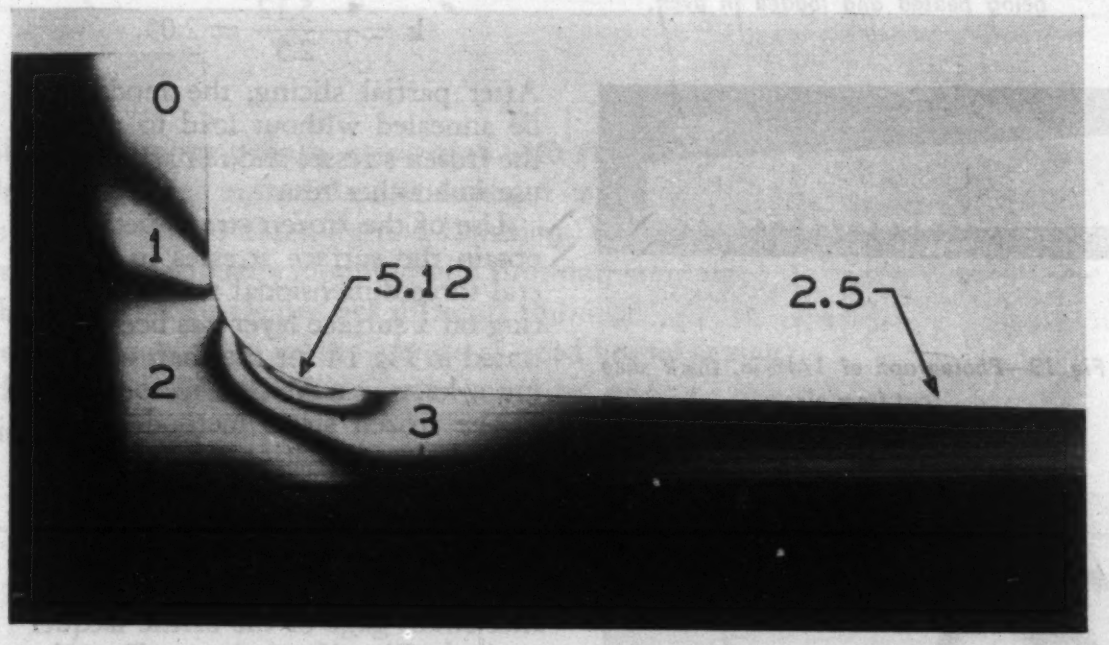


Fig 16—Stress pattern from a partially sliced Fosterite shaft with a central enlarged section subjected to bending.

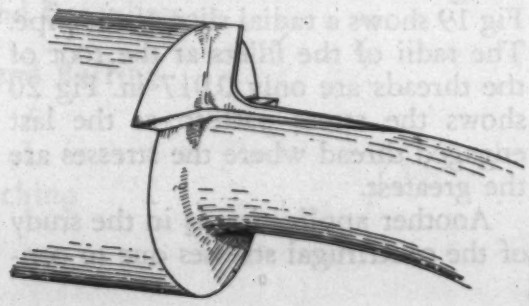


Fig 17—Sketch showing method of partial slicing.

distorted. Fig 15 also shows that very little time stresses form in the Fosterite and Kriston models during the stress freezing process, while an appreciable amount develops in Catalin models.

Table III gives a summary of the properties at elevated temperature of Catalin, Fosterite and Kriston of importance in frozen stress tests.

Table III — Properties of Catalin 61-893, Fosterite and Kriston in Frozen Stress Tests

	Catalin C-61-893	Fosterite	Kriston
Critical Temperature, F	248	194	275
Material Fringe Value, f, Psi	3.30	3.25	6.25
Modulus of Elasticity, E, Psi	1200	1950	13,000
Tensile Strength, $S_{ult.}$, Psi	400	430	680
Figure of Merit, Q=E/f,	365	600	2080
$S_{ult./f}$	121	132	108
Figure of Merit from Fig 15	380	600	1500
Fringe Value from Fig 15	3.30	3.10	6.27
Machinability	Very good	Excellent	Poor
Time Stresses	Large	Small	Small

Applications

Three-dimensional photoelasticity is relatively new, and the lack of suitable materials for model making has limited the use of the method. With the introduction of Fosterite and Kriston, it is believed that more and more use will be made of the method.

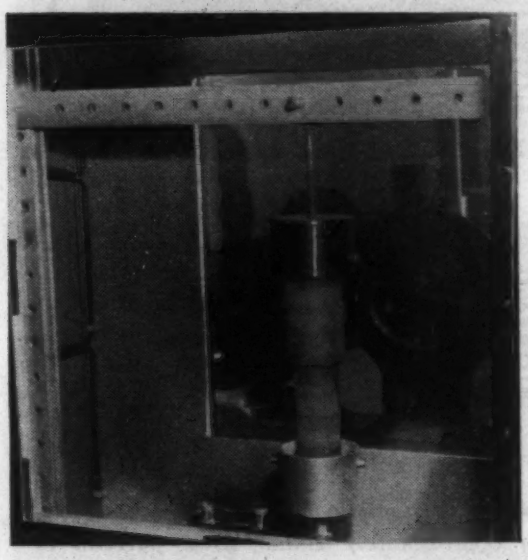


Fig 18—A Fosterite model of drill pipe joint (taper-threaded pipe and coupling) being heated and loaded in oven.

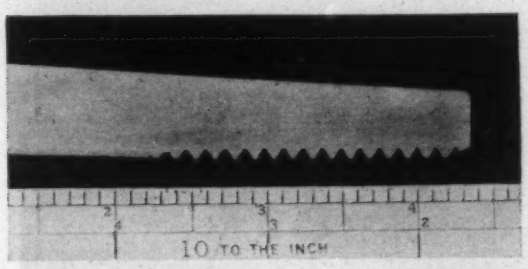


Fig 19—Photograph of 1/16-in. thick slice cut from pipe.

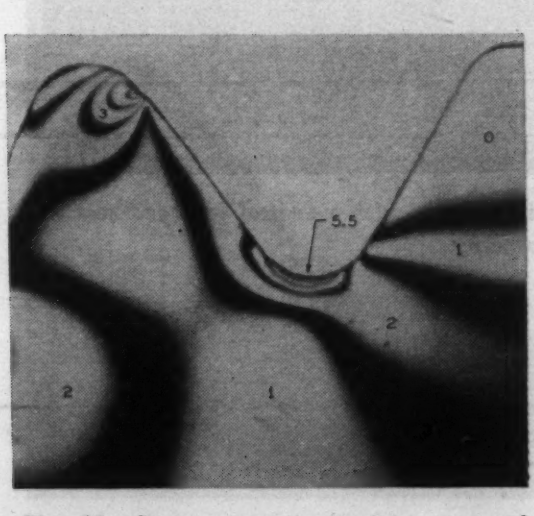


Fig 20—Stress pattern at last engaged thread of pipe joint where stress is greatest.

The use of the frozen stress method to obtain the stresses in machine parts containing sections of symmetry has been illustrated for the poppet valve in Fig 12 and the notched shaft in Fig 13.

Fig 16 shows the stress pattern obtained from a shaft containing a centrally enlarged section subjected to bending. Instead of slicing the entire shaft, only a small part of the shaft was milled off to expose the outer ridge of the slice, as shown in Fig 17. The factor of stress concentration can be determined photographically, as done for the flat bar of Fig 5 (Part 1). Thus, referring to the stress pattern of Fig 16

$$k = \frac{5.12}{2.5} = 2.05.$$

After partial slicing, the model can be annealed without load to remove the frozen stresses and remachined for use in another test.

Use of the frozen stress method to obtain the surface stresses in a general three-dimensional model by cutting off a surface layer has been illustrated in Fig 14 for the shaft containing a keyway subjected to torsion.

The frozen stress method is ideal for the determination of the stresses in threaded joints or other machine parts where it is exceedingly difficult to use other methods of experimental stress analysis, such as the wire resistance strain gage or the brittle lacquer method. Fig 18 shows a Fosterite model of a drill pipe joint consisting of a taper-threaded pipe and coupling being heated and loaded in an oven. Fig 19 shows a radial slice of the pipe. The radii of the fillets at the root of the threads are only 0.017 in. Fig 20 shows the stress pattern at the last engaged thread where the stresses are the greatest.

Another application is in the study of the centrifugal stresses due to constant speed rotation. If the model is heated to the critical temperature, rotated at constant speed, and slowly cooled to room temperature while the speed is maintained, the centrifugal stresses will be frozen into the model and can be obtained photoelastically.

Advantages and Limitations

The photoelastic method can only be used to study elastic stress distributions in homogeneous machine parts or structures. In most two-dimensional tests, the distribution of stress in the model will be similar regardless of the elastic constants of the model and prototype. In three-dimensional tests, the stress distribution in the model and prototype may differ somewhat due to the differences in elastic constants, particularly Poisson's ratio. The strains in photoelastic models are very large (especially in frozen stress tests) compared with those in the metal prototype, and in models involving close tolerances this can cause appreciable error. If careful account is taken of these limitations and sources of error, accurate stress analyses can be made from photoelastic tests.

In many cases photoelasticity is the only method of experimental stress analysis, either because the stressed region is not exposed for the application of strain gages or brittle lacquers, or because the discontinuity is too small for an accurate stress determination using gages of finite length (1/16 in. or greater), or in cases where the stresses at an interior point of a solid object are required.

Photoelasticity has the advantage of furnishing an overall picture of the stresses from which not only the regions of high stress can be determined but also those of low stress. In cases where the prime factor of design may be the reduction of weight, the regions of low stress assume as much importance as those of high stress.

Materials & Methods Manual

69

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

Cleaning and Finishing Stainless Steels

by T. C. Du Mond, Editor, Materials & Methods

The beautiful appearance usually associated with stainless steels is inherent in those materials, but does not come to the surface without proper cleaning and finishing. This manual, which covers the most common cleaning and finishing methods, indicates that stainless steels are not difficult to finish. However, certain precautions, in the nature of good housekeeping practice, should be exercised to assure a beautiful and lasting finish.

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Introduction

One comes to consider the brightness and cleanliness of stainless steel as an inherent quality of that type of steel. Therefore, we are inclined to overlook the fact that these versatile materials do need to be cleaned, polished, buffed and, sometimes, be given special surface treatment for decorative or functional reasons.

While it is true that through proper handling, the mill finishes on stainless steels can be retained through forming and assembly, there are many products which require at least small areas to be restored to a desired finish. One outstanding example is in the case of welded sheets where it is desirable to eliminate the weld seams and make this area conform in appearance to surrounding areas.

As with other features of stainless steel, few generalizations can be made as to finishing the 30 or more standard and semi-standard grades. When special requirements are involved or unusual situations anticipated, it is always well to discuss the specific problems with the producer of the stainless steel involved.

There are, however, certain inherent characteristics of stainless steels which must always be kept in mind when cleaning or finishing are involved. Here are the principal points to remember:

1. Stainless steels are harder and more abrasion resistant than most carbon steels. These characteristics mean that the rate of metal removal in grinding and buffing is lower than might be expected.

2. Stainless steels have less than half of the thermal conductivity of carbon steels. Because of the low heat carry-off, excessive wheel pressures in grinding, buffing or polishing will cause discoloration of the metal and probably lower its corrosion resistance.

3. Chromium-nickel stainless steels have about 40% higher coefficient of expansion than carbon steels. Thus, overheating in finishing will cause distortion and warping, particularly in thin gage material.

4. Stainless steel surfaces are easily contaminated by metal particles which might become embedded. Therefore, metal contaminated abrasives, steel wool and like materials for grinding and finishing should be avoided. For the same reason, grinding wheels, buffs and polishing brushes and other accessories that are to be used on stainless should never be used on other metals.

Most finishing operations are performed on sheet, strip and plate, where high polishes are most desired. Many rod and bar products do not require a high finish and most forgings and castings are satisfactory with a pickled surface, since the majority of such shapes are used primarily for strength, corrosion resistance, or heat resistance rather than for beauty.

Types of Finishing

As is true with most fabricated materials, nearly all stainless products require some type of cleaning operation. Cleaning ranges from wiping with a solvent saturated cloth to those operations involving chemical baths and vapor degreasing. Physically cleaning stainless, of course, involves such steps as descaling or pickling.

To bring out the natural appearance qualities usually associated with stainless steels there are a series of grinding, polishing and buffing operations. Finishing operations of this nature produce surfaces that start with a simple polish on through to sheet that has a mirror finish on both sides. For some finishes as many as 8 or 10 separate steps are required, each involving different polishing agents.

A third, rough grouping of finishing steps would include electropolishing, plating and coloring. These methods are used to achieve high lusters more simply than through normal polishing; to provide a color match or to cut down the reflectivity of the metal for certain types of applications.

Mill Finishes

Sheet—Stainless steel sheets are furnished by most mills to seven standard finishes. Three of the grades of finish are produced in rolling operations, and the other four are attained by additional polishing and buffing. A specific class of finish will not necessarily be comparable in steels of different composition. For example, a 2B finish on 18:8 steels will not look the same as a similar finish on straight chromium grades.

The following are standard AISI finishes.

No. 1—Hot Rolled Pickled and Annealed.

Steel with this finish is used chiefly for technical applications and seldom as a basic raw material for subsequent polishing or buffing. An exception is in those cases where annealing after forming would destroy higher mill finishes.

No. 2D—Dull Cold Rolled.

Stainless with this finish is cold rolled before final annealing and pickling and has a finish much superior to that with a No. 1 finish. Sheets with a No. 2D finish have maximum ductility and drawing quality and a dense, compact surface. The No. 2D finish is specified for most articles to be polished or buffed after forming.

No. 2B—Bright, Cold Rolled.

The No. 2B finish results from a further, light cold rolling in addition to that which produces the No. 2D. The surface is bright and dense and has a slightly harder temper than the No. 2D finish, and, therefore, cannot be drawn as deep or formed as easily as the dull, cold rolled sheet. Where intermediate annealing and pickling is not required, the No. 2B finish is a better surface on which to begin polishing. This finish is usually recommended for making shallow pans and trays, small decorative stampings and similar products.

No. 4—Standard Polish (on 1 or 2 sides).

Influences on Finish

—— resilience of the wheel—grit action varies with firmness.

—— speed—influences cutting action.

—— lubricant—regulates depth of cut.

—— condition of abrasive.

—— type of machine.

Rough polishing of stainless steel is done, where possible, on large machines using revolving abrasive belt machines, as in this U.S. Steel plant.

Either or both surfaces of the stainless are ground with successively finer abrasives to remove all surface imperfections and produce a uniformly bright finish with good luster. A No. 4 finish can be specified for shallow drawing or forming operation in which the original finish will not be destroyed.

No. 6—Tampico Brushed.

This finish is attained by further work on a No. 4 finish by polishing with a rotating tampico fiber brush charged with fine abrasives. The final finish is a conservative, soft satin finish with low reflectivity. A No. 6 finish is used where glare or brilliant reflections are not wanted. Uses include architectural applications or where a contrasting effect with higher finishes is desired.

No. 7—High Luster Polish.

Here is a semi-mirror finish that is more brilliant than No. 4. The last three finishes, Nos. 4, 6, and 7, are not economical where other processing is anticipated because the finish is likely to be destroyed. Finishes to the order of No. 7 are used for dairy machines, restaurant kitchen and counter equipment, and for many kinds of trim.

The finishes described are classed as standard. Higher finishes, including No. 8 (mirror finish) can be achieved and are produced for special purposes. Further information on the special finishes will be discussed in the section on polishing.

Strip Finishes—The most common finishes for strip are the No. 1, which results from the strip being cold rolled, annealed and pickled, and the No. 2, which is produced by those steps plus an additional rerolling. In addition, strip can be finished to the same conditions as those designated as Nos. 4, 6 and 7 in sheets.

Mill Finishes of Plates, Bars and Special Sections—Hot rolled plate is sometimes furnished without being heat treated and without the scale removed, but the final use in this condition is not recommended.

The next plate finish is the hot rolled, and annealed or heat treated condition. Again scale is not removed. Plate with this finish is largely confined to heat resisting applications. The scale lessens corrosion resistance.

The next highest plate finish is attained by annealing or heat treating the hot rolled plate and then blasting or pickling. This is the most preferred finish for corrosion resisting and a majority of heat resisting applications.

A finish similar to a No. 4 finish on sheet is attained by polishing the cleaned surface of annealed or heat treated, hot rolled plate.

Bars—Finishes for bar include:

1. Scale not removed (hot finish)
2. Pickled or blast cleaned
3. Cold drawn
4. Cold rolled
5. Turned
6. Centerless ground } Applicable to round bars only
7. Polished }

Special Shapes, and Irregular Sections—are usually furnished with a pickled finish. Shapes of this nature usually require grinding or polishing with coarse abrasives in the preliminary stages. As with plate, local irregularities must be ground out before general grinding or polishing is started.

In the sections to follow, the general rules applicable to the cleaning and finishing of stainless steels will be outlined in sufficient detail to permit users and potential users to understand the principles involved and determine whether processes and equipment available are satisfactory for use in handling stainless steel.

As has been stressed many times in the literature covering stainless steels, these metals are not difficult to handle. Stainless steels do, however, require considerable care in all steps of processing. The same condition holds true in finishing stainless steels where costly mistakes can result from inattention to important details.

Cleaning, Pickling and Descaling

Depending upon the form in which they are to be used and what type of subsequent finishing is intended, stainless steels will usually require from one to five, or more, cleaning and surface preparation treatments. Cleaning might involve only a simple wiping with a soft, dry cloth or it might require descaling and pickling and passivating. Regardless of what operation is to follow to provide an attractive surface, the final appearance will not be good unless a mechanically clean surface is used as a basis.

Many forming, spinning and machining operations require the use of lubricants, some of which are organic compounds which cling to the surface of stainless steels. Other fabricating steps might require the use of copper, lead or cadmium lubricants. In either case, the compounds must be removed if further finishing is intended.

Parts which are to be annealed after forming should be cleaned to avoid difficulty in pickling and to prevent discoloration of the base metal. The forming compounds normally employed in shaping stainless parts will often burn to the steel surface when heated and thus cause subsequent difficulty in pickling as well as in any attempt to provide an even colored polished surface.

Cleaning

When cleaning stainless to remove greasy lubricants any of the ordinary solvents are used. Whether or not machines or tanks are used depends largely upon the size of the piece being cleaned and the quantity involved.

If degreasing machines or tanks are used, carbon tetrachloride or trichlorethylene are suitable as solvents. Following the actual cleaning, parts are washed in water and then dipped into a hot solution of 10 to 20% (by volume) nitric acid. Where parts are too large for machines, the assemblies are cleaned by rubbing down with cloths saturated with the previously mentioned solvents or kerosene or gasoline.

Where heavy, tightly adhering grease is to be removed it has been found satisfactory to use a paste of soda ash on a soft cloth. Gentle rubbing will remove the soil.

Water-soluble solutions are used to remove some types of forming lubricants. Care must be taken to use compounds that are fully emulsifying. For if the compounds that have been removed are permitted to form an oil film on the surface of the bath, steel surfaces will be recontaminated when they are removed from the bath.

Some soils, including buffing compounds and abrasives, are likely to remain on the metal surfaces after cleaning with solvents. In such cases, degreasing should be followed by washing in warm soapy water. Following the wash, the stainless steel should be immediately dried in warm air or by wiping with a soft cloth.

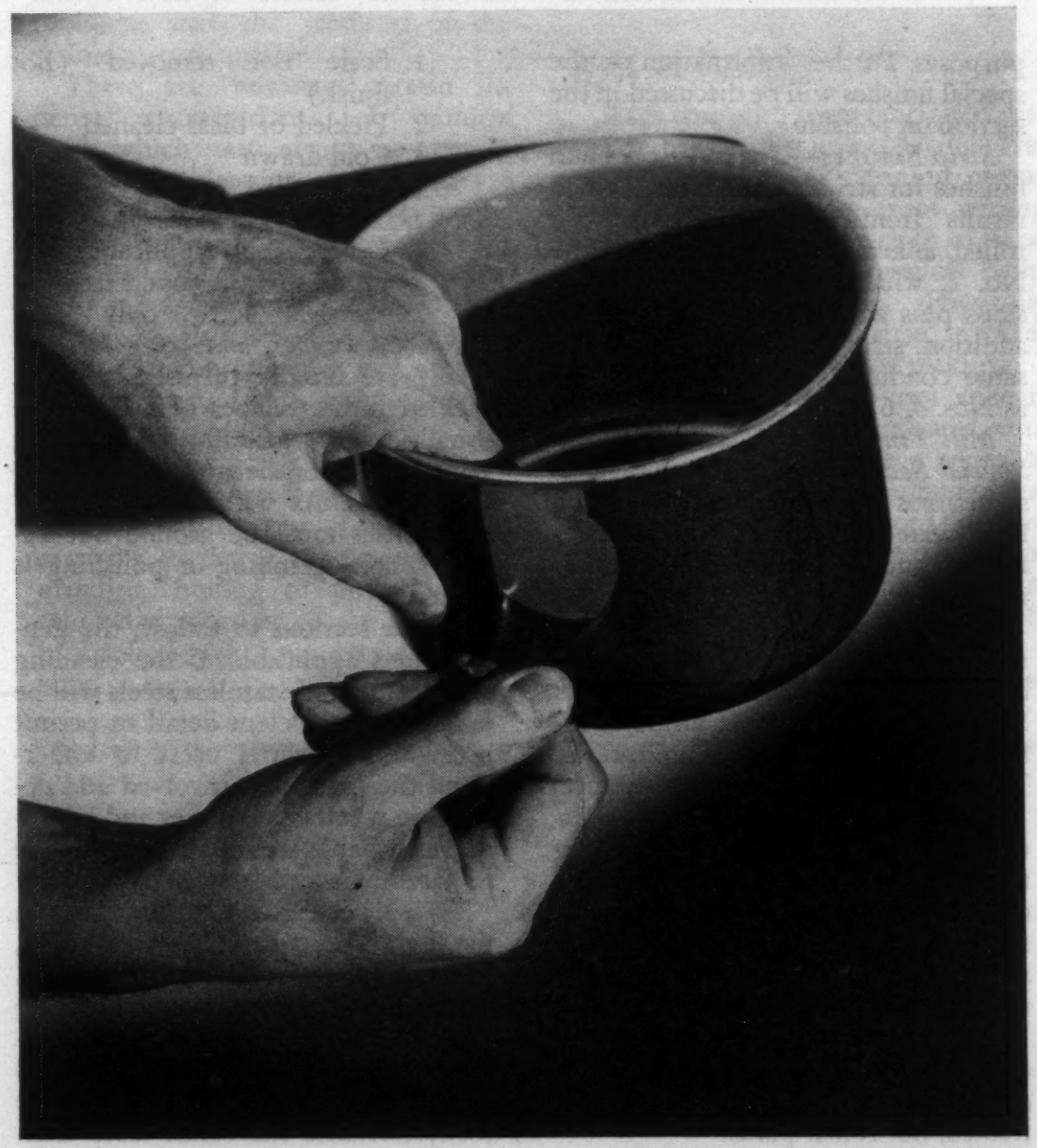
Metallic lubricants such as copper, lead and cadmium used in cold heading, wire drawing and spring winding are best removed by immersing the parts in warm 20% (by volume) nitric acid. The same solution is used to remove lime and lime compounds.

Stains and slight discolorations which mar the surface appearance of stainless steels are effectively removed by using a soft cloth saturated with a 10% solution of sodium citrate. The cloth is then sprinkled with a light layer of whiting. The stains are removed by vigorous rubbing. After the area has been cleaned it should be rinsed and then dried with a clean, soft cloth.

Many fabricators clean stainless steels between polishing operations to make certain that coarse abrasives do not get mixed into the finer grit sizes subsequently used. When such mixing does occur, the surface is likely to be marred and thereby require reworking to take out deep scratches.

Finger marks are undesirable on highly polished stainless steel surfaces or on parts which must be further treated. The removal of fingerprints is easily done by using dry whiting on a soft cloth and wiping gently. Whenever wiping is done in final cleaning, the wiping motion should be carried on in the same direction as the polishing marks and should be done with long strokes.

Mill finishes on stainless steels are often preserved by means of removable plastic coatings, which are stripped from parts after forming has been completed.



Otherwise variations in color are likely to result.

Scale Removal

The forging, heat treatment or annealing of stainless steel parts usually results in a tight, hard scale which forms when parts are permitted to cool. For most uses the scale must be removed from all surfaces to provide a base for further finishing or to improve appearance without further treatment. An occasional exception is where stainless is to be used only for its heat resistant properties. Scale impairs the corrosion resistance of stainless steels.

Pickling is by far the most common method used to remove scale in plant fabricating of stainless steels. However, there are some cases where a more severe treatment is necessary. When extremely thick scale is to be removed, sand blasting is resorted to. In producing plants and fabricating plants where large quantities of plate are involved, sodium hydride descaling is used rather extensively. Other salt baths are also used for descaling small parts. In still other circumstances tumbling or water quenching are employed to remove the scale.

Pickling—The type of pickling solution to be used on stainless steels depends upon a number of factors. For example, composition of the stainless steels being pickled is important, so is the thickness of scale; likewise, the prior annealing practice.

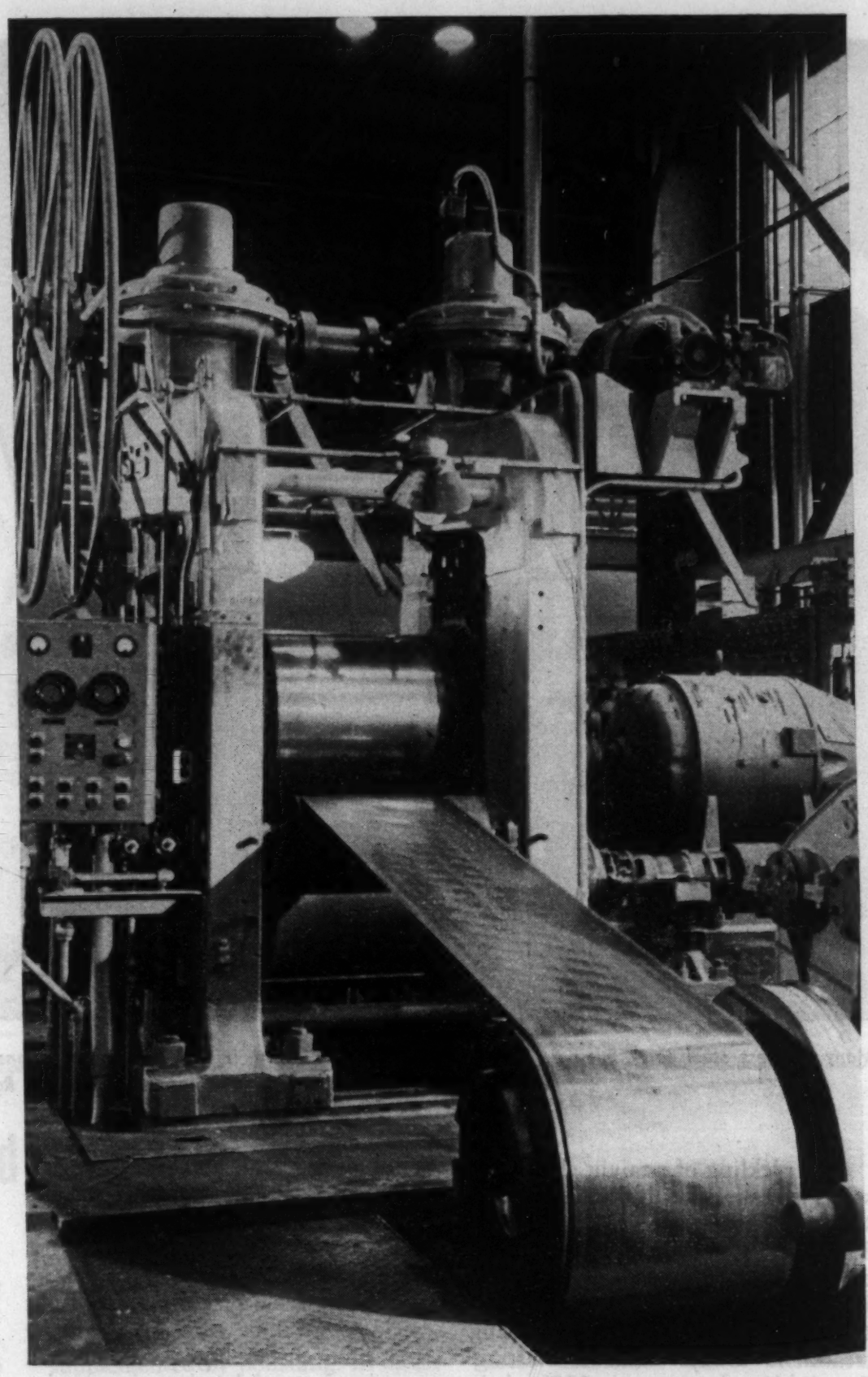
Solutions of nitric and hydrofluoric acids prove most satisfactory in pickling the chromium nickel steels. Solutions vary, depending upon the oxides to be removed, with 5 to 25% nitric acid and 1 to 4% hydrofluoric acid, by volume being used. When scales or oxides are light, a solution containing 12 to 15% nitric and 1% hydrofluoric acids is usually satisfactory. Where heavier oxides are involved, the ratio of nitric to hydrofluoric acid should be lowered. Nitric acid inhibits the action of hydrofluoric acid. Therefore, higher ratios of nitric acid do not cause as much metal loss as lower ratios. Solutions of this type are used at temperatures between 120 and 140 F.

Hydrochloric acid is sometimes substituted for hydrofluoric acid in the pickling solutions for chromium-nickel stainless steels. A satisfactory solution includes 25% nitric and 1% hydrochloric acid. The ratio of nitric to hydrochloric acid should always be kept above 10 to 1 to prevent excessively rapid attack on the metal.

Mixed acid solutions, such as those just described, will attack unstabilized chromium-nickel stainless steels in weld zones unless the steels have been annealed after welding.

The acid solution pickles must be followed immediately by a water wash and immersion in a 10% solution of nitric acid at 140 F, followed by another thorough wash in hot water.

One manufacturer of stainless steels recommends a two-step pickling process. By this method, the scale is first softened and partially removed in sulfuric or hydrochloric acid and then completely descaled and whitened in a nitric-hydrofluoric solution. The first step requires 8 to 11% sulfuric acid at 150 to 160 F and the metal is soaked for 10 to 45 min. If hydrochloric acid is used, concentrations are 10 to 15% at 120 to 140 F for 30 to 90 min. These acids require inhibitors, and parts must be rinsed thoroughly before passing on to the second step.



Stainless steel passing through Crucible's new temper mill is given special physical and surface finish properties. For many uses, the finish thus acquired is entirely satisfactory.

Many stainless steel parts, but particularly small ones, are given their final finishing by means of tumbling barrels. Cleaning and burnishing are both done by tumbling in machines such as this Roto-finisher.

The pickling of straight chromium steels is more difficult than is the case with chromium-nickel stainlesses. The tight scale which adheres after certain treatments, such as slow cooling, can only be removed by sand blasting. A pickling or passivating treatment always follows blasting. For the latter purpose, a 15% nitric acid solution at 140 to 160 F is used.

When quick cooling is used on heated straight chromium steels, the scale that is formed is readily removed by pickling. For the purpose a solution containing 8 to 12% sulfuric acid, by volume, and 2% sodium chloride is used at 140 to 160 F, after a water wash. An immersion in a 15% nitric acid solution is then recommended.

Individual fabricators of stainless steels usually develop for their own use pickling methods which best suit their own needs. Most of them conform rather closely with those described here, but are altered slightly to meet localized conditions.

Blasting—Scale removal by means of blasting is not the most suitable method in cleaning stainless steel, but it sometimes becomes necessary. Some scales are too tight to be removed by usual pickling methods, or scale removal by pickling might be too time consuming. As mentioned previously straight chromium stainlesses which have been slowly cooled after annealing developed an extremely dense scale which can only be removed by blasting.

Blasting is achieved by iron-free sand, stainless steel shot, or aluminum oxide grit being impelled against the work by air or mechanical action. Care must be taken that the blasting action does not cause the scale to be embedded in the stainless steel surface.

In addition to seeing that no scale becomes embedded, care must be taken to make certain that no ordinary steel shot, iron-containing sand or other potential sources of rust are used in the descaling process. Blasting, while useful, is seldom used on products made of sheet, strip or tube.

During the blasting process it is important that the force of the blasting stream be kept even and constant. The force is also diffused to prevent any unevenness of surface that might hamper subsequent grinding and polishing. Blasting covers the descaled surface with a myriad of microscopic depressions. The resultant roughness impairs corrosion resistance of the stainless steel, but that quality can be restored by polishing.

To be safe, most fabricators of stainless steel parts follow blasting operations with a pickling step to make certain that all scale has been removed. Likewise a passivating treatment is recommended.

Salt Bath Descaling—One of the newest methods of removing scale and oxides from stainless steel parts is through the use of salt baths. First used in steel plants, non-electrolytic salt bath descaling is now used in many fabricating plants on a wide

variety of parts. Two different methods are in use today. The methods vary in the type of reaction and salt bath operating temperatures. Both methods offer an advantage in that the salts do not attack the metals being descaled.

The sodium hydride process developed by du Pont uses a bath consisting of caustic soda plus 1.5 to 2.0% sodium hydride at a temperature of 700 to 800 F. Action of the bath is due to the sodium hydride reducing oxides in the scale to the metallic state, thus turning scale into a loose, flaky mass. Quenching the part in cold water after an immersion period of up to 30 min., depending on size of part and type of scale, causes steam to be generated. The steam blasts most of the scale from the stainless steel surface.

The second method, the Hooker process, used proprietary salts, known as Virgo salts. This salt bath contains an oxidizing agent which causes the oxides in scale to become more acid-soluble. Action of the bath causes scale to swell and loosen from the base metal. Scale breaks off when the part to be descaled is subsequently plunged into cold water. The Virgo salt bath is operated at temperatures ranging from 850 to 1250 F, depending upon the application.

Usually parts which have been descaled by either of the methods described are given a 2 to 3 min. dip in hot sulfuric or hydrochloric acid to remove any remaining scale and clean the steel surface. A water rinse follows. In some cases no acid dip is necessary, while in others, a nitric acid dip is required for bleaching or passivating.

Some users of the salt baths find them useful in removing oxides formed in welding and brazing as well as in removing joining fluxes.

Tumbling—Tumbling is sometimes used to remove scale from stainless steel parts that have been stamped, drawn or machined close to final shape and dimensions. A finish approaching that of a buffed finish can be attained by the proper combination of abrasive, speed and time. Tumbling can cause surface contamination that might result in rusting, so passivation is recommended after tumbling.

Passivating

Treatments which usually follow the cleaning, descaling and pickling of stainless steels to remove any foreign soils from the surfaces are generally known as passivating treatments. Actually, these processes do not passivate the surfaces, but rather insure a clean stainless steel surface by removing materials which might cause rusting or discoloration.

Stainless steel parts after machining, polishing or pickling are usually given a short dip in relatively dilute nitric acid solutions (15 to 20% by volume). Times vary from 10 min. in a warm (150 F) solution to 30 min. in a cold bath, or perhaps somewhat longer for less acid-soluble soils.

True passivating requires a special treatment for any of several groups of attacking media which might be encountered. For example, stainless steel can be made somewhat more resistant to the action of hot sulfuric acid by boiling it in 50% nitric acid for about an hour. The same effect can be achieved in a boiling 3 to 5% solution of sodium bichromate, but the treatment period is 48 hr.

Localized attacks of solutions containing chloride ions can be reduced by a bath in an aqueous solution of 4% hydrofluoric acid and 4% chromic acid. The bath operates at 140 F and period of immersion is about 30 min.

Passivating treatments are impermanent because the surfaces thus provided can be destroyed by wear, bending, scratching, or long contact with reducing solutions.

Grinding, Polishing and Buffing

The type of finishing operation performed on stainless steel depends entirely upon the service for which the part is intended. For example, a piece intended primarily for high temperature application would probably be used without any finishing other than possibly grinding to size. On the other hand, stainless steel to be used for food and chemical processing should be given a fine, scratch-free surface. Some uses require a mirror-like surface and others merely that the surface be moderately smooth and clean.

Where welding has been used in the fabrication of stainless steels, it is often desirable to finish the welded joint in such a way as to make it blend with the base metal's surface. In many cases finishing the weld bead will cover the entire range of grinding, polishing and buffing.

Grinding, polishing and buffing are all related and are similar in many respects. All methods employ a wheel or abrasive carrier of some type and an abrasive and the equipment used is identical. Grinding results in comparatively coarse finishes, which are supplemented by polishing. In finishing stainless steels finishes through the #6 finish are attained by grinding and polishing. Finishes better than a #7 are achieved through buffing.

Because of their high strength, stainless steels are somewhat more difficult to grind than ordinary carbon steels. Being tougher than mild steels, the stainlesses tend to drag and thus wear out wheels more rapidly. Stainless steels do not conduct heat rapidly and, consequently, can easily be overheated. Overheating will cause metal discoloration and warping.

Grinding and Polishing

Where grinding and polishing of stainless steel is done to improve surface quality rather than to attain a give size, wheels with some "give" to them are preferred to the solid or hard wheel used for metal removal.

Wheels—Flexible wheels give the best decorative effect on stainless steels. The amount of metal removed depends, of course, upon the fineness of grit employed. While the term wheel is used generally, there are many instances where abrasive strips or belts are used satisfactorily. On high production jobs where special shapes are involved, formed wheels are sometimes used to good advantage.

When grinding and polishing are done on stationary equipment such as a polishing lathe, wheels used measure 12, 14 or 16 in. in diameter. When portable equipment is used, 5 or 6 in. dia. wheels are used. Wheel width depends primarily upon the size and shape of parts being finished.

Wheel speeds of between 6,000 and 8,000 surface ft. per min. are the safest in finishing stainless steels. However, depending upon circumstances, speeds as low as 5,000 surface ft. per min. and as high as 9,500 surface ft. per min. are used. When speeds are too low the abrasive is wasted and when too high, the stainless is likely to be overheated and warped.

Abrasives—Aluminum oxide is the most satisfactory abrasive for grinding stainless steel because it is hard, tough and uniform. This abrasive has a peculiar self-sharpening characteristic which helps somewhat in overcoming the loss of life which could be expected from stainless steel.

When emery is to be used, the artificial type is preferred to natural emery, because the former can be guaranteed iron-free. Iron or iron oxides in abrasives for grinding or polishing stainless are extremely harmful and should be avoided.

If grinding is started on a sheet with a #1 finish, a grit of #60 size is usually coarse enough. Should the surface be exceptionally rough as, perhaps, in the case of a welded joint a #36 grit abrasive might be used. A definite sequence is then followed to provide the desired surface. A difference of no more than 40 grit numbers between abrasives is usual between steps in grinding and polishing. In other words, if the grit first used is #60, the next should be #100.

Where extremely large amounts of grinding are involved, some shops prepare their own grinding and polishing wheels. Making wheels of the type needed is a specialty and requires considerable special equipment and experience. Therefore, most stainless steel fabricators are content to buy their grinding wheels, belts and other abrasive products.

Lubricants—Many kinds of lubricants are used in grinding and polishing stainless steels. Most frequently used are kerosene; mixtures of kerosene and machine oil; heavy machine oil; palm oil; mutton tallow and stearic acid sticks. Lubricants prolong the cutting life of the wheel or belt and have considerable control over the type of finish obtained. Because lubricants must later be removed, those that are saponifiable are most desirable.

Lubricants load abrasives and permit cutting by the tops of the grains only. This action reduces the depth of cut of any abrasive. A change in lubricant in various stages of grinding or polishing can sometimes substitute for a change in abrasive sizes.

The greatest percentage of stainless steel sheet and plate is used with a No. 4 finish, but there are times when finishes superior to No. 4 are desired. Procedures for obtaining such finishes are charted in an accompanying table. Too, damage to stainless steel surfaces often occurs during fabrication, making necessary the refinishing of sections of the finished part.

To illustrate the early stages of grinding and polishing, perhaps it might be well to go through the steps necessary to bring a weld bead to a No. 4 finish.

If the weld bead stands above the adjacent surface, it is ground down to approximately the level of the general area. Flexible shaft or portable tools can be used on this operation (No. 1) using either a #36 or #60 grit rubber- or Bakelite-bonded wheel at a speed of 7,000 to 8,000 sfpm. Grinding should continue until a broadening base indicates that base metal has been reached. Grinding should be in the direction of the weld bead to prevent dishing.

The second operation on weld beads would coincide with the starting point in working towards a No. 4 finish on heavy gage sheet or plate. In this step, a #80 grit is used in a cloth wheel also operating at 7,000 to 8,000 sfpm. Grinding should continue until all heavy grit lines have been eliminated, if this step follows step #1. If an initial operation on sheet or plate, grinding continues until all surface imperfections are removed.

The third step follows No. 2 whenever used, but is also the starting step in polishing light gage sheets. A lubricant is used in operation No. 3 to help bring up the color of the stainless. A cloth wheel is used in this step, and, as in the case of the two preceding steps, speed of the wheel is between 7,000 and 8,000 sfpm. This operation is completed when all grit lines from the second operation have been ground away or until a uniform polish is reached.

Step No. 4 is short and relatively simple. It is used only long enough to attain the finish which is accepted as the standard No. 4 polish finish. Here, a #120 or #150 grit is used with tallow or some similar lubricant.

Several other steps can follow to reach special finishes on stainless including further polishing, buffing, tampico brushing or wire brushing. Finishes provided through the operations listed are all for special purposes.

Buffing

When stainless steels are buffed, the surfaces become lustrous and highly reflective to a degree not possible by polishing alone. Buffing usually

Don'ts

in Grinding and Polishing Stainless Steels

1. Don't use too much pressure, otherwise discoloration and distortion might occur.
2. Don't break in a new wheel or belt on a scrap of the same material upon which it is to be used.
3. Don't judge an abrasive by its first cutting action in making finish comparisons.
4. Don't grind with different grit sizes without an intermediate cleaning operation.
5. Don't overwork the abrasive by trying to remove too much metal.
6. Don't forget that a fine grit will remove more metal from a roughened surface.
7. Don't polish across previous scratch lines, and make certain that all scratches are straight and parallel.
8. Don't overpolish.
9. Don't mark polished surfaces.

follows grinding with a #240 grit or higher which produces surfaces on which all scratches and defects have been eliminated. Buffing is done by means of muslin buff sections built up to the required width. Some are similar to the cloth wheels used in grinding and polishing, but abrasives used are not anchored to the buffs as in the other operations. Abrasive or polishing media are used in stick form and applied to the wheel by pressure when the wheel is in motion.

There are available many types of buff all developed for special characteristics, but all have some features in common. Most standard buff sections are made of approximately 20 plies of cloth. Several buff sections are then built up to a width determined by the needs of parts being finished. In buffing stainless steel a cloth count of 86/93 is widely recommended. As high speeds are used to buff stainless steels, and because those metals are tough, some makers recommend that the "ventilated" type of buff be used to prevent scorching.

Cutting qualities of buffs depend upon the ability to gather the cutting compound and hold it effectively during the buffing operation. Metal is cut away by the composition, not by cloth. The type of cloth used controls holding of the compound; sewing and puckering, the stiffness. Hard buffs, naturally enough, cut faster than the soft types. Buffs are in the same size range as wheels for grinding and cutting: 12 to 14 in. dia and 3-in. face for polishing lathes, and 6 to 8 in. dia and 1½ in. face for portable tools.

Most buffing involves two operations—cutting and coloring. Cutting, as its name indicates, actually removes a small quantity of metal. The cutting operation is done with a wheel speed of about 10,000 sfpm using a fast cutting aluminum oxide in stick or cake form. Coloring is done at a somewhat slower speed. Color, the mirror finish in stainless, is brought out by using a white compound of grit-free alumina type. There are many proprietary buffing compounds available for specific conditions and the recommendations of their manufacturers can be relied upon.

In some instances, coloring and buffing are done on a machine having a constant speed. In such cases correct speeds for the two steps can be attained by using buffs of different diameters.

Tampico Finish

The standard No. 6 polish finish for stainless steels is also known as a satin finish or tampico brush finish. The surface is smooth and a dull matte in appearance, is free of polishing scratches and has reduced reflectivity. To produce a finish of this standard, a No. 4 finish or better is needed to start. The effect is gained by brushing with a tampico fiber brush that is loaded with fine abrasive, such as pumice, and a lubricant. Quality of a tampico finish depends upon the starting surface, so it is not unusual to buff the steel before using the tampico brush.

Brushing is done at speeds up to 5,000 sfpm with brushes that range from 6 to 16 in. in dia. Stationary or portable tools can be used. On large flat surfaces, the abrasive and lubricant is often applied as a paste on the surface and then picked up on the brush. With portable tools, abrasive sticks are applied to the wheels.

Best results are obtained in tampico brushing when brush lines are applied in the rolling direction of the metal. The use of long strokes is advisable because lap marks will be eliminated as will spots that are polished to a higher finish than the rest of the work.

Sequence of Operations for Grinding, Polishing and Buffing Stainless Steels

Sequence of finishes which can be produced when starting with No. 1 pickled finish or No. 2D or No. 2B cold reduced finish.

Finish	Operation Sequence	Abrasive	Lubricant	Wheel	Speed, Sfpm
Welds	—	Aluminum Oxide Grit No. 40-60	Dry	Rubber or Bakelite bonded	4000-6000
No. 1	1	Aluminum Oxide Grit No. 60-80	Tallow or grease stick	Cloth wheel	6000-8000
No. 2D or No. 2B	2	Aluminum Oxide Grit No. 80-100	Tallow or grease stick	Cloth wheel	6000-8000
No. 4	3	Aluminum Oxide Grit No. 150	Tallow or grease stick	Cloth wheel	6000-8000
No. 6	3B*	Pumice lime or silica flour	Tallow or grease stick	Tampico brush	2500-5000
No. 7	4	Aluminum Oxide Grit No. 180	Oil and/or kerosene	Cloth wheel	6000-8000
	5	Aluminum Oxide Grit No. 240-280 abrasive stick	—	Buff	9000-10,000
	5B*	Stainless buffing compounds	—	Buff	7000-9000
No. 8	6	Aluminum Oxide Grit No. 320-400 abrasive stick	—	Buff	9000-10,000
	6B*	Stainless buffing compounds	—	Buff	7000-9000
Scratch-Free Mirror	7	Stainless buffing compounds	—	Buff	7000-9000
	8	Stainless buffing rouge	—	Buff	7000-9000

** Operations 3B, 5B and 6B are special steps to finish off at the respective No. 6, No. 7 and No. 8 finishes. When working through to a higher finish, B operations are not used.*

Barrel Finishing

Some stainless steel parts are too small to be cleaned and polished by the usual methods. Such parts as pen points, grommets, eyelets, and other tiny shapes are best finished by barrel polishing methods. Barrel polishing is not restricted to small parts, but does prove most valuable with pieces that would be difficult to hold.

In barrel polishing the parts to be finished are carefully agitated in a precise curve while suspended in a polishing medium. There are all types and shapes of barrels, but most rotate at speeds ranging from 15 to 60 rpm. Barrel polishing is divided into two primary operations—cutting down, or honing, and ball burnishing.

Honing—To cut down the stainless steel surface, work is loaded into the polishing barrel with a mineral abrasive, water and, quite often soap.

The abrasive action of the slurry as it sloshes over parts being honed removes and smooths burred edges and removes light surface imperfections. One of the most frequently used abrasives seems to be aluminum oxide.

Abrasives used are classified according to size and shape. Tumbled abrasives—those on which corners have been rounded off—give a mild cutting action and, therefore, cut slower but give smoother finishes. Cutting results from pressure from the weight of the parts on the abrasive material as the barrel rotates. Abrasive is used in the ratio of about four to one by volume in respect to work, with the total load being between ½ and ⅔ of the barrel's capacity. Cutting action is controlled to some extent by water volume. Rapid grinding and roughing is the result of a low water level. Additional water slows the cycle but provides a better finish.

Ball Burnishing—Burnishing is not intended to remove metal from stainless steel. It is used to develop a high luster on the steel surfaces through the action of countless contacts with balls impinging on the surfaces. The action tends to press and make the surface more dense. Ball burnishing usually follows a preliminary barrel polishing operation.

In ball burnishing stainless steels, stainless steel balls, cones, disks or pins are preferred. The use of carbon steel balls might require the parts being finished to be passivated, even though soap and water in the mix act as insulation.

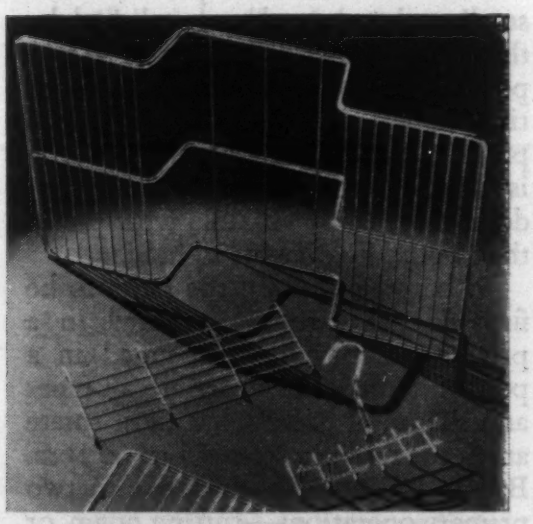
Whether a ball, disk or pin be used as the shape of burnishing medium depends upon the type of part being finished. Likewise the size of the individual burnishing ball or shape must be such that the medium can get into all crevices on surfaces to be finished. When balls are used, the radius of the balls must be less than any radius in that area.

Usually, two volumes of balls to one of work are loaded into the barrel. The barrel is filled to about two-thirds of capacity and then the contents covered with water. Finally, burnishing soap is added to serve as a lubricant. Barrels, generally wood-lined, rotate at speeds of between 30 to 60 rpm for periods varying from 1 to 8 hr. Some authorities recommend Vienna lime in place of soap, but this material requires some variations in the process. An unlined steel barrel is used. One and one-half lb. of lime is used for each gallon of water. In the final slaking of the lime, heat is generated, making necessary ample ventilation of the barrel. Lime is mildly abrasive and will remove from 0.0015 to 0.0002 in. of surface in a period of 24 to 36 hr. When burnishing has been completed, lime is cleared from the barrel by flushing with hot water. Next the barrel is run for a few minutes with burnishing soap added to the water and burnishing medium.

Finally, parts are removed from the barrel and dried in another barrel, using vegetable fiber, ground corn cob or some other absorbent material.

Electropolishing

A few years ago there was developed an electrochemical method of polishing stainless steel which has been highly successful on many kinds of work. Electropolishing, as the process is known, is accomplished by a procedure that is almost the exact opposite of electroplating. The process is patented by Armco Steel Corp., but is available to users on a licensing arrangement.



The stainless steel electropolishing method patented by Armco is highly valuable in finishing objects that would be difficult to polish by hand methods, such as these refrigerator shelves.

Electropolishing is considered as a supplement to other finishing processes rather than as a replacement for any of them. It works to best advantage on surfaces which are broken up by radii, ribs, perforations and other surface interruptions which tend to make grinding and polishing difficult.

Here are some of the types of work on which electropolishing has been used with great success: Regular or irregularly formed or drawn parts; intricate wire products; resistance welded wire products; parts too small to buff; and deeply recessed parts.

Forgings

There is some metal removal in electropolishing, but the loss is slight. On most surfaces and with normal polishing times, metal removed ranges from 0.0002 to 0.001 in. on all exposed surfaces. The amount of metal displaced is sufficient to knock off some high spots, including burrs on small parts, and to remove signs of discoloration resulting from resistance welding.

For best results, electropolishing should be done on stainless steels which have smooth, dense surfaces that are free from tool marks and other surface defects. Cold finished steels polish best by the electrochemical method, and while all analyses of stainless can be electropolished, the chromium-nickel grades respond best.

Surfaces which are to be electropolished must be cleaned of lime, copper, lead, cadmium or other fabricating lubricants. Ordinary greases and oils can be taken off by vapor degreasing, but metallic coatings might require chemical dips. Other than providing a moderately clean surface, no special pretreatments are necessary for electropolishing.

In electropolishing, the work to be polished acts as the anode which is submerged in an acid electrolyte and made to respond to a cathode in the bath. When properly performed, the set-up results in metal being taken from the anode (the part) and deposited on the cathode. The result is a bright and shiny surface on the parts. Highly important to the success of electropolishing is the relationship of the cathode to the work as far as both distance and shape are concerned.

Equipment for electropolishing is relatively simple. A tank for the electrolyte; a source of 6- to 12-v dc power; a method of heating and controlling the heat of the electrolyte; cathodes; rinse tanks; holding racks; and simple electrical control equipment comprise the list.

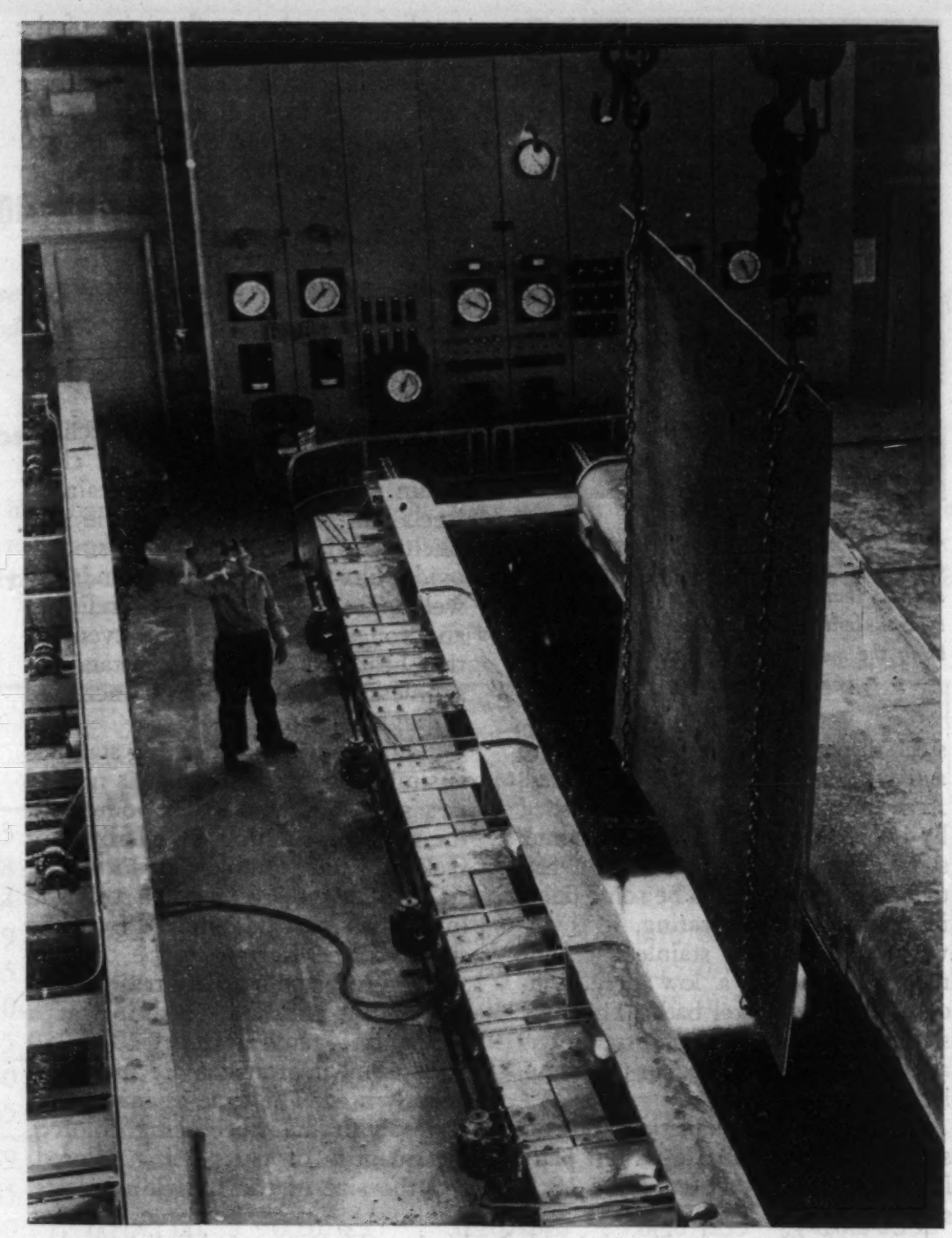
There are two methods of electropolishing which differ primarily in

the chemical composition of the electrolyte and in operating temperatures. One method offers a choice of two electrolyte chemicals: (A) Citric-sulfuric acid, and (B) glycolic-sulfuric acid. Solution (A) operates at 180 to 200 F and (B) at 170 to 190 F. The second methods uses a phosphoric acid-butyl alcohol combination and is operative in the 120 to 160 F range.

Electrolyte baths are usually heated by immersion methods or by steam coils. Heat generated in electropolishing helps maintain the bath temperature. Sometimes, in fact, facilities must be maintained for removing excess heat. The time required for electropolishing depends upon original finish of the part, current density, bath temperature and the shape of the part. The usual time for polishing ranges between 2 and 10 min. Rough surfaces, of course, require longer polishing times than do smooth surfaces. Longer periods of electropolishing are not harmful other than in continuing to remove metal slowly. The usual rate of metal removal is 0.001 in. in 10 min at 1 amp per sq in. current density. Higher current density increases speed of metal removal.

Work to be polished is connected to the positive current lead and submerged. Work is located about an inch away from the cathode element. The cathode is attached to the negative current lead. When the set-up is operating, metal, which is removed from the work as it becomse polished, plates onto the cathode.

Cathodes are made of lead, copper or stainless steel in the form of wire, strips or perforated metal. At times the tank itself can be used as a cathode. When tanks are of 500-gal capacity or less, cathodes average ⅛- by 1-in. strips; larger tanks use strips ¼- by 3-in. Cathodes are hung vertically in the tanks. When deep drawn parts are being polished, it is sometimes necessary to make cathodes conform to the work in order that current density be uniform over the entire area to be polished.



Salt bath descaling was first used primarily to remove mill scale on large stainless steel shapes, as on this Lukens clad plate. Now either of two methods are used for all sizes of objects.

Agitation is usually necessary in electropolishing baths to move the heavy layer of gas which forms on work surfaces. The presence of gas makes impossible uniform polishing.

Plating, Coloring, Etching

There are often situations which require treatments on stainless steels to modify or disguise their natural appearance. Sometimes the changes are desired for the sake of appearance only, but usually the mechanical qualities of stainless steel are desired in some application where a bright surface cannot be tolerated.

Electroplating

During the last few years there have been an increasing number of circumstances under which the plating of stainless steel has been desirable. In most cases the plating has been to make the steel surface match chromium-plated parts on automobiles. Highly polished and buffed stainless does not have the brilliance of chromium, so a thin plate is necessary where color matches are important. Although usually not a reason for plating, chromium does protect the stainless from slight surface rust which could result from improper cleaning.

Chromium is plated directly to stainless steel without an intermediate plate of copper or nickel, or both. However, some platers pass stainless

If extra high finishes are desired on stainless steel parts, buffing is relied upon. Rather than abrasives, as in polishing, special buffing compounds are used to bring the metal to a high color. (Courtesy Lea Manufacturing Co.)

steel through a highly acid bath to activate the surfaces to be plated. Activation is frequently accomplished by immersion in a 20%, by volume, sulfuric acid bath operating at 160 to 200 F. If there is to be some delay in plating after activating, it is advisable to give the stainless a flash nickel coating in a low pH, high- or all-chloride nickel bath. The steel should be rinsed after this treatment and before being placed in the regular plating bath.

One of the largest plating jobs on stainless has been in chromium plating automobile bumpers. Here 18:8 stainless (Type 301) is plated in a solution of 42 oz-gal chromic acid, ½ oz-gal sulfuric acid. Plating requires high current density, and the bath is operated at 120 F. Plating time is about 4 min.

Stainless steel must be highly polished and buffed before plating if the full brilliance of the chromium plate is to be realized. However, experience has shown that plating should be done within 20 hr of buffing in order that the oxide film which forms on the steel does not become so dense as to interfere with plating.

Chromium and nickel plating are most commonly used on stainless steels. However, other metals are used in plating for special purposes. An example is gold, which is used on some stainless steels destined for handling medicines or foods. Gold is also used to provide unusual decorative schemes on stainless.

Coloring

Stainless steels are often used in applications where reflectivity of the material is undesirable. Sand blasting and etching do not reduce the glitter sufficiently, so the metal must be treated in some other way. The usual solution is to color the steel with an oxide film. Most of the processes for coloring stainless are patented, although many are available for use under simple and relatively inexpensive licensing arrangements. An example of the use of coloring is on Garand rifle parts, where reflectivity could be fatal.

A blackening process which is widely used on both straight chromium and chromium-nickel stainless steels will serve to illustrate the simplicity of the treatment. The smooth oxide film which results stands up well under adverse weather conditions and rough handling. Some even say that heat and corrosion resistance of stainless steels are slightly increased through coloring.

Equipment for blackening stainless is simplicity itself. All that is needed is a steel tank, some heat source for the coloring solution, and baskets or racks in which to hold the work.

All scale, grease or other soils and impurities must be removed from the stainless steel surface to be colored.

Parts to be colored are treated in a dichromate solution operating at a temperature ranging from 720 to 750 F. Sodium dichromates are most frequently used. The time of immersion varies with the steel being colored, the quantity of parts being colored, and the size of the individual parts. The average time, however, is about ½ hr. After a suitable immersion period, parts are permitted to cool to room temperature, then they are hot rinsed, and, finally, dried by means of an air blast. Baths for blackening can be used intermittently as long as the temperature of the bath never exceeds 785 F.

Blackening can be removed selectively, when desired, by electrochemical methods. The blackened surface can also be enhanced by waxing.

Also patented is a process of coloring stainless to several golden shades. Preparation for the process only involves cleaning and drying the stainless parts. Parts to be colored are dipped into solutions of molten sodium nitrate or potassium nitrate. Mixtures of the two chemicals are also used. Temperatures of the baths range from 730 to 840 F, with the highest temperatures producing the deepest tones.

The 18:8 stainless steels are best suited to gold coloring, particularly if they have been polished previously. At 775 F, Types 302, 303 and 304 can be colored in from 5 to 40 min, depending upon size and section thickness. Straight chromium stainlesses take somewhat longer.

After coloring, the parts are cooled, rinsed and dried. Some users like the gold colored parts to be oiled for a deep, uniform luster; others protect the finish with coatings of clear lacquer or varnish.

Etching

To achieve special decorative effects on stainless, it is sometimes necessary to etch certain areas. There are mechanical and chemical methods of etching which are poles apart as far as complexity of the processes are concerned. Chemical etching requires considerable special equipment and techniques which are too involved to merit description here. At the other extreme, mechanical etching is so simple that it can be done by anyone.

There are two mechanical methods of creating an etched appearance on stainless. One involves tampico brushing and the other sand blasting. In either case, the starting point is stainless with a #4, 7 or 8 finish. Portions which are to remain polished are masked with a heavy tape. The exposed portion of the surface is then brushed or blasted, as the case might be, long enough to produce the desired surface. When tampico brushing is used, a suitable abrasive is used. Cleaning is desirable after either brushing or blasting. Cleaning should be done before masking is removed so the polished surfaces will not be damaged.

Conclusion

As with all other processes having to do with stainless steel, cleaning and finishing must be individually tailored to the shop in which the work is done. However, the foregoing information should be sufficient to permit an intelligent appraisal as to the processes best suited to work which might be considered. The producers of stainless steel are most cooperative in supplying information and technical assistance in order that their materials be used to best advantage. The same is true of suppliers of cleaning and finishing materials and equipment.

In the preparation of this manual, the author relied heavily upon the technical literature of the major producers of stainless steels, and takes this opportunity publicly to express his thanks.

Materials Engineering File Facts

NUMBER 207
April, 1951

New Steel Compositions to Conserve Critical Alloying Elements

Five new grades of steel have been developed to conserve manganese, nickel, chromium and molybdenum. These steels are in the early stages of production.

Boron Steels 80Bxx, 81Bxx and 94Bxx

The 80Bxx series is designed to have hardenability equivalent to the 86xx steels at the same carbon content. The 81Bxx series is likewise designed to have hardenability equivalent to the 41xx steels at the same carbon content. 94B17 is designed to have hardenability equivalent to 4820. These steels can be expected to have 0.0005% minimum boron content.

Grade	Chemical Composition Limits, %					
	C	Mn	Si	Ni	Cr	Mo
80B20	0.17/0.23	0.45/0.70	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B25	0.21/0.28	0.50/0.75	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B30	0.27/0.34	0.55/0.80	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B35	0.32/0.39	0.65/0.95	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B40	0.37/0.45	0.70/1.00	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B45	0.42/0.50	0.70/1.00	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B50	0.47/0.55	0.70/1.00	0.20/0.35	0.20/0.40	0.25/0.50	0.08/0.15
80B55	0.50/0.60	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
80B60	0.55/0.65	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
81B35	0.32/0.39	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
81B40	0.37/0.45	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
81B45	0.42/0.50	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
81B50	0.47/0.55	0.75/1.05	0.20/0.35	0.20/0.40	0.35/0.60	0.08/0.15
94B17	0.14/0.20	0.70/1.00	0.20/0.35	0.30/0.60	0.30/0.55	0.08/0.15

Grade 81xx Steels

Grade	Chemical Composition Limits, %					
	C	Mn	Si	Ni	Cr	Mo
8115	0.13/0.19	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8117	0.14/0.20	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8120	0.17/0.23	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8122	0.19/0.25	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8125	0.21/0.28	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8127	0.24/0.31	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8130	0.27/0.34	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8132	0.29/0.36	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15

(Continued on page 107)

"B&W ALLMUL FIREBRICK *gives me twice the performance for my money!"*

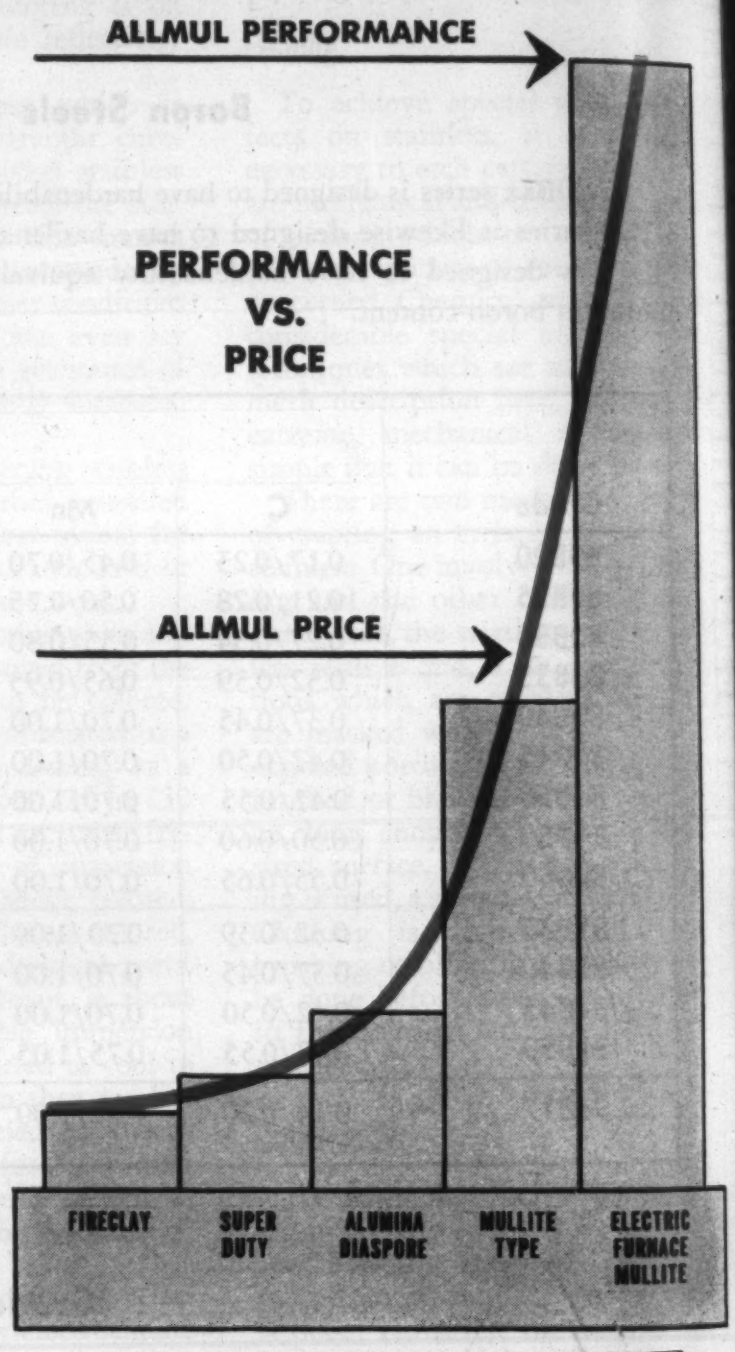
You, too, may discover new and truly important ways to save money with B&W ALLMUL — the new performance-proved, electric-fused mullite fire-brick. B&W engineers have designed special mass production methods to produce this incomparable firebrick at a cost hitherto considered impossible. One result is the performance vs. price ratio charted at the right. And it's a big result, economically.

Another is a long list of Allmul repeat orders for the most severe service applications — ferrous and non-ferrous melting furnaces, slag melting furnaces, glass tanks, checker chambers, ceramic kilns and many others.

The properties described in the panel below explain why Allmul eliminates need for frequent furnace relining, cuts maintenance and saves valuable production time.

If you have not already investigated this remarkable new firebrick, we urge you to do so at once. The sooner you start using B&W Allmul, the greater your ultimate savings will be. SEND FOR NEW BULLETIN R-29.

ALLMUL is another important refractories development by B&W engineers who have continuously established new standards in industrial furnace refractories for the past 30 years.



CHECK THE PROPERTIES OF ALLMUL!

Here's how B&W Allmul stood up under standard tests.

SPALLING—12 cycles of heating to 2550F and chilling in cold air and water spray. **Result—no loss.**

HOT LOAD DEFORMATION—1½ hours at 3050F under load of 3600 pounds per square foot. **Result—less than 2% deformation.**

PERMANENT VOLUME CHANGE UNDER REHEATING—After 5 hours at 3200F. **Result—less than ½% change.**

FACT—no other firebrick in Allmul's price range can match its performance. **Fact**—no mullite brick at **any** price can better the performance of B&W Allmul.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: AUGUSTA, GA.

R 394

B&W REFRACTORIES PRODUCTS — B&W 80 Firebrick • B&W Junior Firebrick • B&W 80 Glass Tank Blocks • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS—Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

Materials Engineering File Facts

Grade 81xx Steels

Grade	Chemical Composition Limits, %					
	C	Mn	Si	Ni	Cr	Mo
8135	0.32/0.39	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8137	0.34/0.42	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8140	0.37/0.45	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8142	0.39/0.47	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8145	0.42/0.50	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8147	0.44/0.52	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
8150	0.47/0.55	0.75/1.05	0.20/0.35	0.20/0.40	0.35/0.60	0.08/0.15
8155	0.50/0.60	0.75/1.05	0.20/0.35	0.20/0.40	0.35/0.60	0.08/0.15
8160	0.55/0.65	0.75/1.05	0.20/0.35	0.20/0.40	0.35/0.60	0.08/0.15

Modified 86xx Steels

Grade	Chemical Composition Limits, %					
	C	Mn	Si	Ni	Cr	Mo
Modified 8615	0.13/0.19	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8617	0.14/0.20	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8620	0.17/0.23	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8622	0.19/0.25	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8625	0.21/0.28	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8627	0.24/0.31	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8630	0.27/0.34	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8632	0.29/0.36	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8635	0.32/0.39	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8637	0.34/0.42	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8640	0.37/0.45	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8642	0.39/0.47	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8645	0.42/0.50	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8647	0.44/0.52	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8650	0.47/0.55	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8655	0.50/0.60	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15
Modified 8660	0.55/0.65	0.70/1.00	0.20/0.35	0.40/0.70	0.55/0.80	0.08/0.15

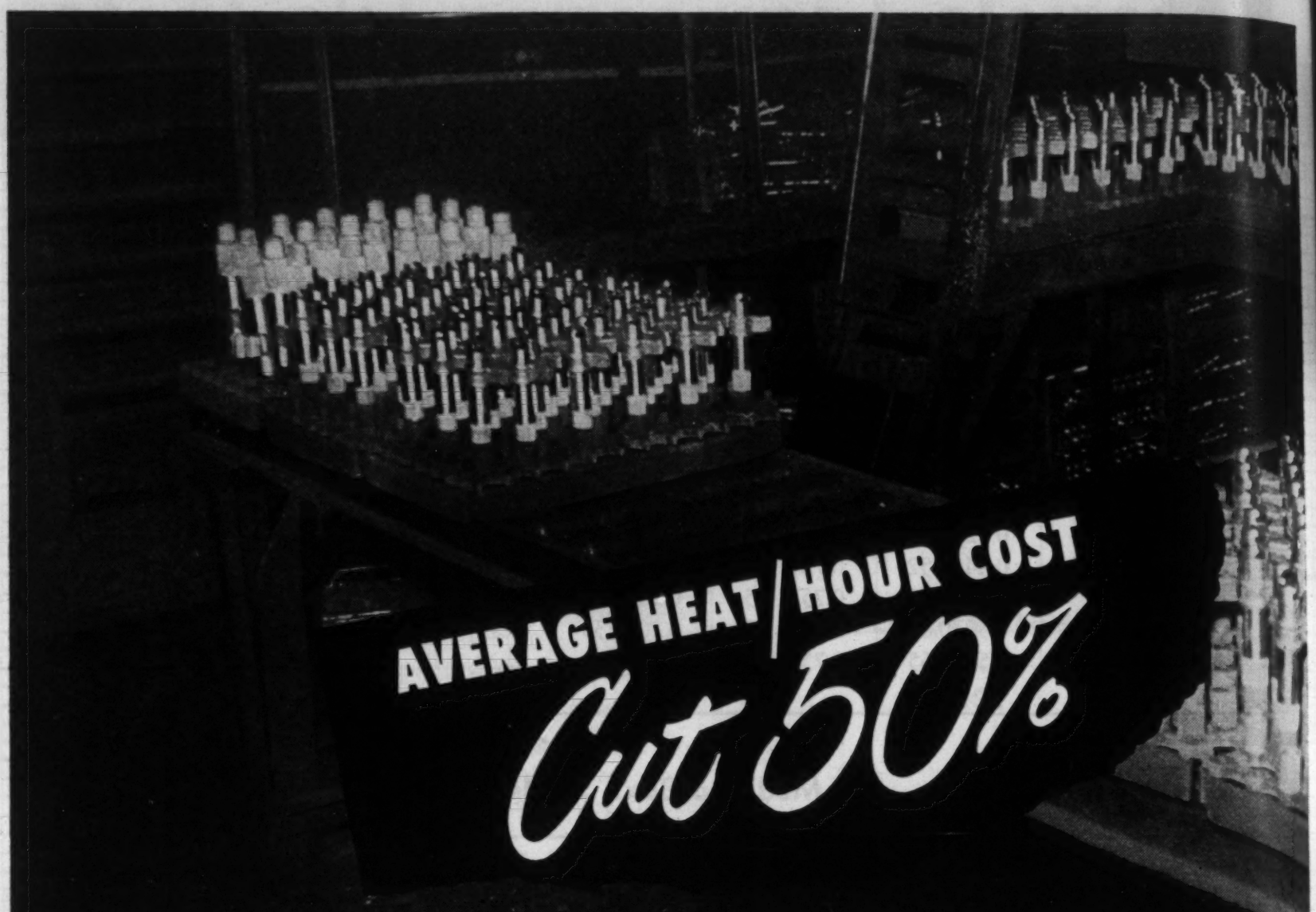
Note 1. The phosphorus and sulfur limitations for each steelmaking process are as follows:

Basic electric furnace —0.025 max %
Basic open hearth —0.04 max %
Acid electric furnace —0.05 max %
Acid open hearth —0.05 max %

*Note 2. **Minimum silicon limit for acid open hearth or acid electric furnace alloy steel is 0.15%.***

*Note 3. **Small quantities of copper are present in alloy steels which are not specified or required. This element is considered incidental and may be present in an amount not exceeding 0.35%.***

*Note 4. **The ranges and limits shown above apply to steel not exceeding 200 sq. in. in cross-sectional area, or 18 in. in width, or 10,000 lb in weight per piece.***



...using THERMALLOY* trays and grids for carburizing application

	Average Cost per Heat/Hour	Average Hours Life
Thermalloy	.0048¢	6707
Tray "A"	.0095¢	3443
Tray "B"	.0092¢	3022

(*Note:* Figures do not include trays damaged in furnace wrecks, by rough handling, etc.)

The trays and grids shown above are used for carburizing automotive gears at a temperature of 1650° F. Through the use of Thermalloy "50", plus certain design changes, average cost per heat/hour has been cut in half... average hours of service life more than doubled. (See figures at left.)

This is one of many cases where customers have greatly benefited from Thermalloy's heat-resistant properties... plus the ability of Electro-Alloys engineers to develop designs suited to ideal foundry practice as well as to customer service requirements.

Thermalloy is not just one alloy, but a group of alloys ... each specially adapted to certain heat and abrasion requirements. Our engineers can assist you in selecting the type best suited to your particular needs... recommend designs that will insure maximum service life.

To put such knowledge to work for you, just phone your nearest Electro-Alloys office, or write Electro-Alloys Division, 2084 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

Materials & Parts

Plastic Fittings

Carlon Products Corp., 10225 Meech Ave., Cleveland 5, recently announced the development and production of a new line of injection-molded plastic reducing bushings and end plugs for use with Carlon plastic pipe.

Available in 15 different sizes ranging from 2 by 1½ to ¾ by ½ in., the bushings can be used to join sections of plastic pipe or to connect Carlon plastic lines with previously installed metallic systems.

Molded of pure plastics, these new fittings will not contaminate fluid, vapor or gas being conveyed.

Molded from a single piece of thermoplastic material, the new fittings are said to bring all of the inherent advantages of plastics to the field of fluid and vapor transmission. They are extremely light in weight, can be installed rapidly and easily, and are claimed to assure leak-proof connections.

According to the manufacturer, these fittings are resistant to the same wide range of chemicals as Carlon plastic pipe, and they are guaranteed against rot, rust and electrolytic corrosion.

Cellular Rubber

Recently introduced by *Sponge Rubber Products Co.,* Shelton, Conn., a newly developed cellular rubber compounded of Hycar Pa-21 is said to be lower in price, but possess much of the high temperature efficiency of cellular silicone rubber.

Uses for this new material are claimed to be desirable in commercial and defense applications such as grommets, pads, gaskets and shock mounts requiring resistance to ozone, oil and gasoline, and excellent compression set properties.

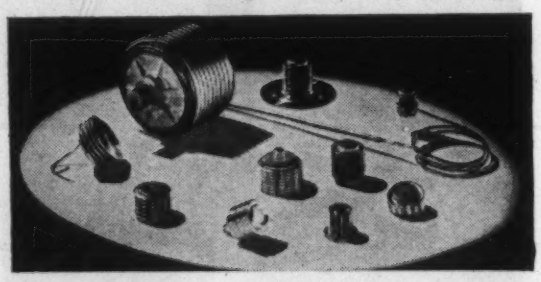
In performing at intermittent temperatures of 400 F and for a week continuous at 300 to 350 F, the new stock contrasts with standard crude stocks which melt after a few hours at 300 F and the company's best crude high temperature stock which deteriorates after three days at 300 F.

Open or closed cell structure is available, the open cell material having poor resistance to water, in that it swells, while the closed cell material is said to be practically impervious to water.

Developed to function at high temperatures, the new cellular rubber stock is not efficient at temperatures below freezing.

New Type Bellows

Manufactured of brass, stainless steel, bronze, monel and Inconel, the Flexon bellows now being offered by *Chicago Metal Hose Corp.,* 1316 S. Third Ave., Maywood, Ill., are available in a complete range of sizes dependant upon application requirements.



These bellows are available in a complete range of sizes and metals.

According to the manufacturer, the bellows are especially suited for applications connected with control devices and instrumentation, such as regulators, valves, steam

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New Materials and Equipment
(CONTINUED)

traps, shaft seals, expansion connections and flexible connectors for misalignment.

Flexon bellows can be furnished with a variety of fittings to meet customer specifications. Many types of attachments can be provided, such as those for silver brazing and soldering.

Plastic Battery Separator

Possibility of shortage in the country's battery production because of diminishing supplies of good wood and of natural and synthetic rubber could be eliminated by a new plastics battery separator, according to *Electric Storage Battery Co.*, Philadelphia, manufacturer of the new unit.

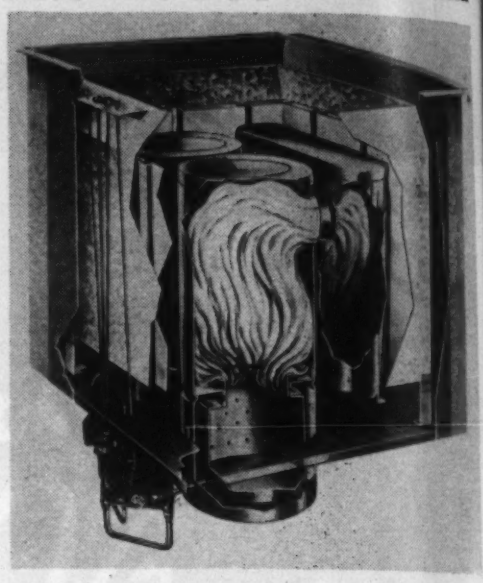
Called Pormax, the new plastic separator is a polyvinyl chloride synthetic said to be porous, nonbrittle and more acid resistant than either wood or rubber separators.

Separator deterioration due to oxidation is one of the major causes of automobile battery failures. According to company engineers, Pormax separators in batteries in the laboratory and on the road demonstrated that their quality and life are equal to the total lifetime of several sets of wood separators in automobile batteries.

Heat Resistant Finish

An improved heat resistant finish, Scion, formulated from a silicone base, has been announced by *Midland Industrial Finishes Co.*, E. Water St., Waukegan, Ill.

Formerly marketed under the trade name, Mico, the product has now been



The combustion chamber of the Superflame Floor Furnace where temperatures reach 870 F has been successfully coated with the new heat resistant finish.

further improved and refined, and is claimed to exhibit unusual stability at temperatures as high as 1000 F. The finish gains its notable heat resistant properties from the amazing silicones, heat stable organosilicon oxide polymers about which so much has been learned in recent years.

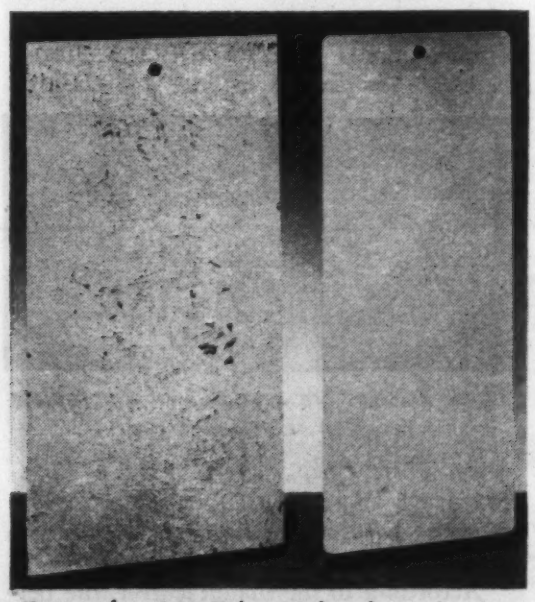
According to the manufacturer, Scion has been thoroughly proved on the production line for such products as industrial furnaces, heating units and similar products and it is recommended by the manufacturer for protecting and preserving the surfaces of a wide variety of products where ordinary heat resistant finishes fail.

Available in easy-to-apply form by brush, dip or spray, the finish requires only a chemically cleaned surface.

Coatings & Finishes

Coating Resins

Three silicone alkyd coating resins have been announced by the *Plaskon Div., Libbey-Owens-Ford Glass Co.*, Toledo 6, as the first chemically combined silicone alkyd resins commercially available.



Exposed to 350 F for 50 hr, the melamine-alkyd resin enamel on panel at left failed, while the plaskon silicone showed no effect.

Designated Plaskon ST-856, ST-873 and ST-881, the resins are expected to find wide use in military applications because of their important properties, particularly resistance to heat, weathering, humidity, chemicals and salt spray, and satisfactory performance under widely varying climates.

Expected uses for silicone-alkyd resins will be in coatings for space heaters, transformers, motors, chemical and refinery equipment, ships, and automotive exhaust pipes.

The ST-856 resin is a baking enamel for general industrial use where heat is deleterious to usual coating films and excellent durability is necessary. ST-873, its counterpart, is an air-drying resin which can be used for larger finishing areas than could be baked. Potential use for this resin is in consumer and maintenance paints, since it can be brushed or sprayed on. The third resin, ST-881, is a vehicle for aluminum or similar pigment paints and is said to have the advantages of durability, flexibility, adhesion and ability to maintain its film properties at extremely high temperatures.

All three resins are intended to be used as one-coat applications.

Protective Coating

Tinallium, a new protective coating in the form of a nondrying black paste, has been announced by *American Sand-Banum Co., Inc.*, 9 Rockefeller Plaza, New York 20.

Said to be adaptable for all metals, woods and concrete mixes for preservation against weathering conditions, acids, fumes and chemicals, it also constitutes protection against alkali, rust, corrosion, oxidation, heat, cold, steam and other destructive agencies either above or below ground.

According to the manufacturer, the outstanding properties of the new coating are:

1. Will not stain water or other liquids, and will withstand contraction and expansion.
2. Fire resistant and water repellent.
3. Contains no lead oils, graphite, creo-

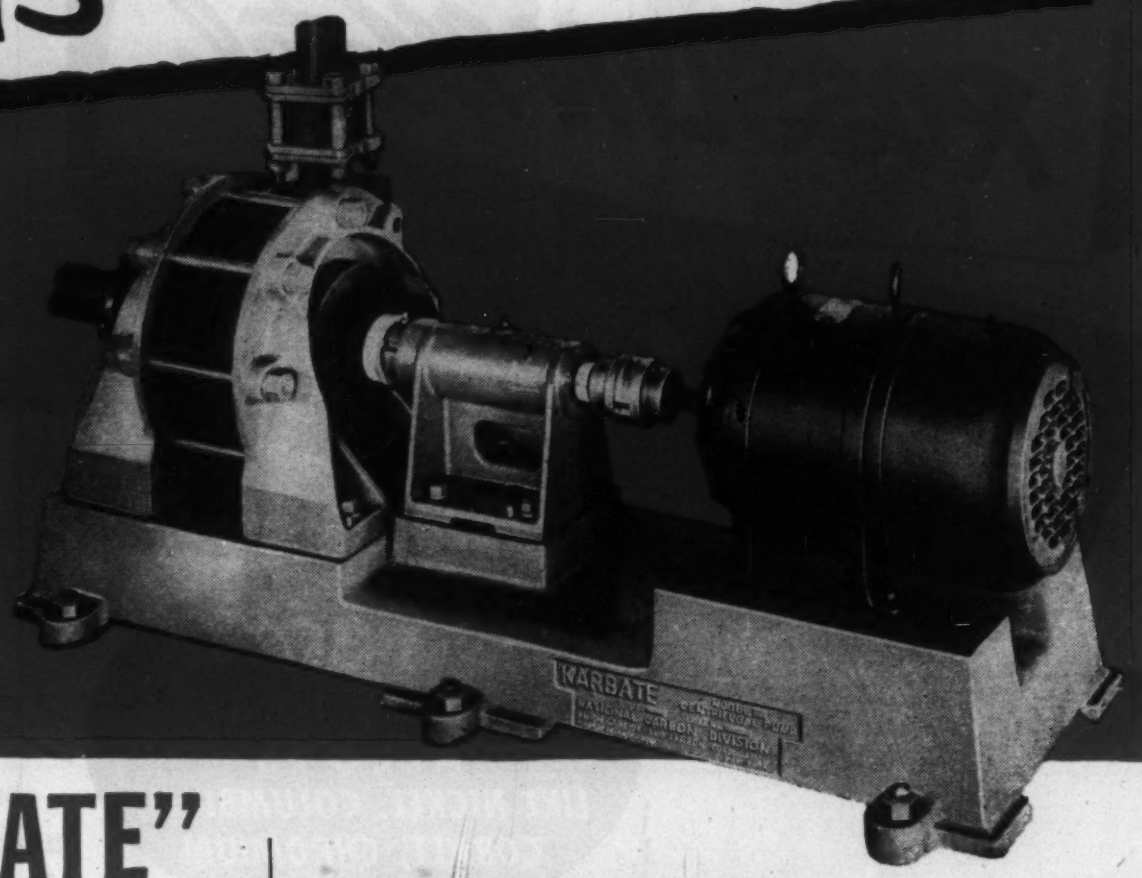
NOW SAVE 2 WAYS

not only by—REDUCED PRICES

but also thru—

LOWER MAINTENANCE COST

To the savings made by the reduction in "Karbate" brand impervious graphite pump prices (up to 33%), add the all-important factor of *very low annual maintenance cost.* Our records show some pumps in service for years, requiring practically no replacement parts.



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Impervious Graphite Corrosion Resistant

PUMPS

HERE'S WHY—

- Case and Impeller are of "Karbate" impervious graphite — they do not corrode.
- Stainless Steel Shaft, where exposed to corrosive fluids, protected by "Karbate" impervious graphite.
- "Karbate" impervious graphite rotary seals* are regular equipment — included in basic pump price. They are not "extras".
- No stuffing gland to require packing — a single, occasional adjustment of the "Karbate" rotary seal replaces this cost.

Other NATIONAL CARBON products

*Now, even at new low pump prices, "Karbate" rotary seals have been improved. Teflon is used to gasket the seal to the shaft and the gasket is adjusted, independently of pressure, on the seal faces.

OTHER FEATURES:

- All-purpose application
- Freedom from product contamination
- Excellent corrosion resistance
- Rugged construction
- Low maintenance — minimum servicing and replacement of parts

The term "Karbate" is a registered trade-mark of

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ROSSLYN Metal

SAVES 30% OF HARD TO GET ALLOYS LIKE NICKEL, COLUMBIUM, COBALT, CHROMIUM

- **Eliminates Hot Spots**
- **Sometimes can be used in lighter gauges**
- **Excellent mechanical and physical properties at elevated temperatures**

At high temperatures (600° F.-1800° F.) there's a place for Rosslyn Metal!

Wherever you're confronted with structural failure in stainless sheets because of warping and cracking and local burn-through due to poor heat conductivity . . . *Rosslyn Metal* should be investigated. Because it conducts heat so well, it is often unnecessary to build for extra strength to combat the effects of hot spotting when *Rosslyn Metal* is used.

Rosslyn Metal can be fabricated easily by any of the common methods . . . welding, punching, deep drawing, spinning, etc.

These and other advantages can result from your use of *Rosslyn Metal*.

Full technical data on request

AVAILABLE IN ALL STANDARD SHEET GAUGES AND STANDARD MILL SIZES

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New Materials and Equipment

sote or tar, and stops decay, rust and rot.

4. Nonpoisonous.

5. Can be applied by brush while cold regardless of atmospheric conditions, and has large spreading out ability.

6. Temperature range of from 75 to 500 F.

Protective Ceramic Coating

A new ceramic coating for metals and alloys that is said to withstand oxidation, corrosion, flexing, vibration, percussion and severe thermal shocks has been developed by *Elraco Engineering Co.*, 158 Fourteenth St., Hoboken, N. J.

In addition to providing a protective barrier against corrosion and oxidation at temperatures up to 2400 F, Elkote is also claimed to withstand prolonged immersion in corrosive liquids. According to the manufacturer, the new coating adheres firmly to metals of widely different coefficients of expansion, even when subjected to flexing, percussion and sudden extreme temperature changes.

Protective Finish for Zinc

Manufacturers and plating shops now switching to die castings and zinc-plated steel can protect those parts with a special clear lacquer or a synthetic finish, according to *Maas & Waldstein Co.*, Newark, N. J.

The finishes are Dulac Clear Universal Lacquer #462 which is air-drying, and Codur Clear Synthetic Y743 for baking. Both are claimed to have fully demonstrated their ability to stand up under salt spray and weatherometer tests for a period of 800 hr.

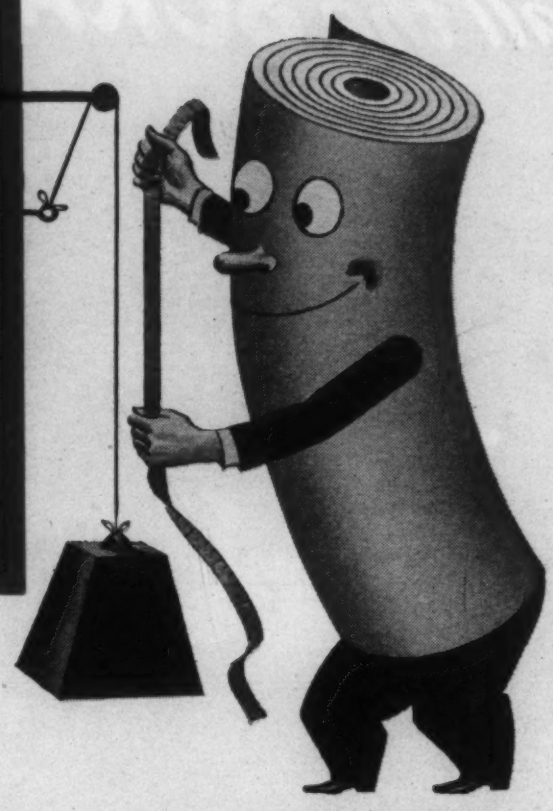
Zinc-die castings protected with these coatings are said to show no discoloration after long periods of service.

Multi-Use Primer

Formulation of a new rust inhibiting primer which can be used for spraying or dipping applications has been announced by *James B. Sipe and Co.*, Pittsburgh 16.

According to the manufacturer, Multi-

Industrial FABRICS To Fit Your Needs



Whether your production problem involves the creation of a new fabric for your purposes—or adapting an existing fabric to your needs—or driving a textile "bug" out of your present production setup — we believe you'll find Mt. Vernon-Woodberry has the skill and experience it takes to work it out. Can we help?

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STANDARD FABRICS
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Double and Single Filling
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Dryer Felts
Narrow and Wide Drills
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all the SCRAP you can!

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UNITCASTINGS
for you and our Government !

Serious shortages exist in all types of scrap;
You can all help us by directing it back.
Select and collect all the scrap that you can
And sell it or give it to your local scrap man.
Vital production can then best be enrolled,
To bring quicker relief in these times of control.

UNITCAST
Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

New Materials and Equipment

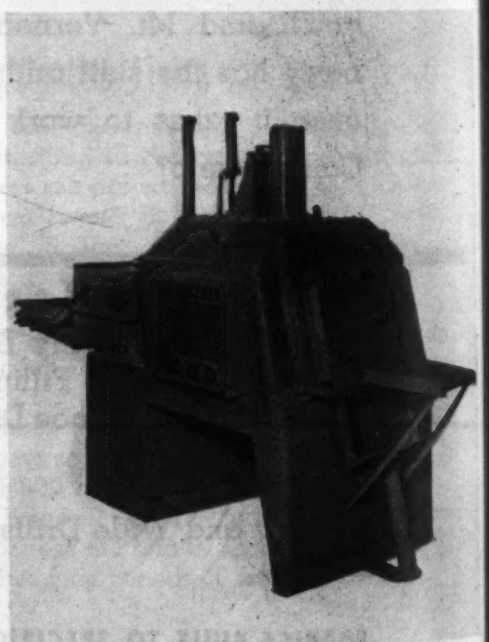
Use Primer—available in gray, red, yellow and black—can be used on almost any clean ferrous or aluminum surface. Basically, it is a rust inhibiting synthetic primer which reduces with Toluol or Xylol for spraying or dipping.

This primer is said to either bake or air dry with equal facility, and can be cured simultaneously with its top coat in a one-bake operation. A 15-min baking operation at 300 F is sufficient to thoroughly dry the primer, while 10 min of air drying is claimed to be adequate to allow handling.

Heating, Heat Treatment

Bright Heat Treating Unit

Designed for bright heat treating, carburizing, carbonitriding, annealing and copper brazing, a new semi-automatic controlled atmosphere unit, the T-100-E, has



The furnace of this new heat treating unit is electrically heated, using eight bars for 16-kw input.

been announced by *Ipsen Industries, Inc.*, 715 S. Main St., Rockford, Ill.

Consisting of a furnace sealed to a combination cooling chamber and quenching tanks, the unit is rated as 100 lb per hr, while its maximum operating temperature is 2100 F.

Work is manually loaded into the fur-

Be a wise bird about tubing

Bundyweld Tubing, double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

Why get yourself out on a limb with a tubing part that can't deliver the goods in your product?

Be like other wise birds and rely on Bundyweld . . . for lines that hold, come shaking or vibration, for coils that form right, or frames that are strong. The more stringent your needs, the better.

No other small-diameter tubing offers as much as this double-walled type of Bundy ® tubing. It's extra sturdy, won't leak under pressure or give under normal strain. It's thinner walled, conducts heat faster and fabricates with ease.

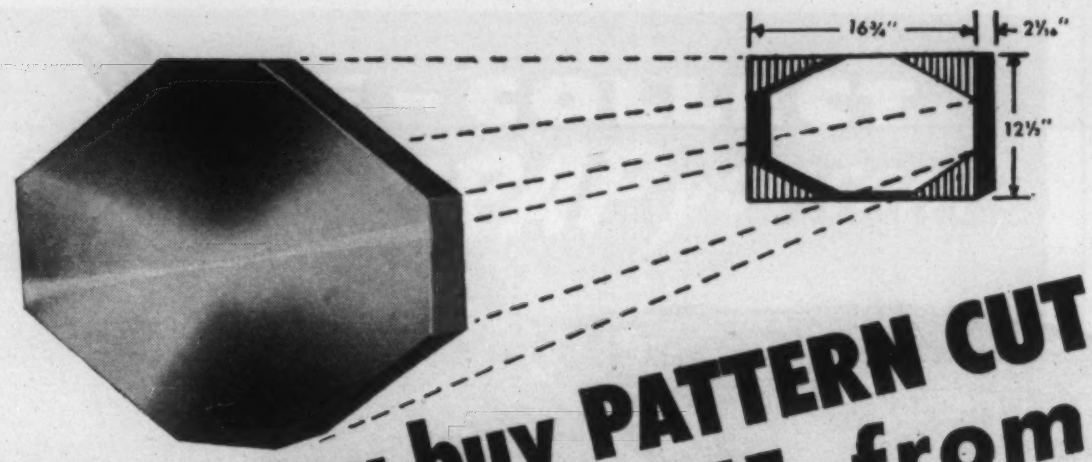
For details, just get in touch with headquarters for small-diameter tubing . . . today.

Bundy Tubing Company

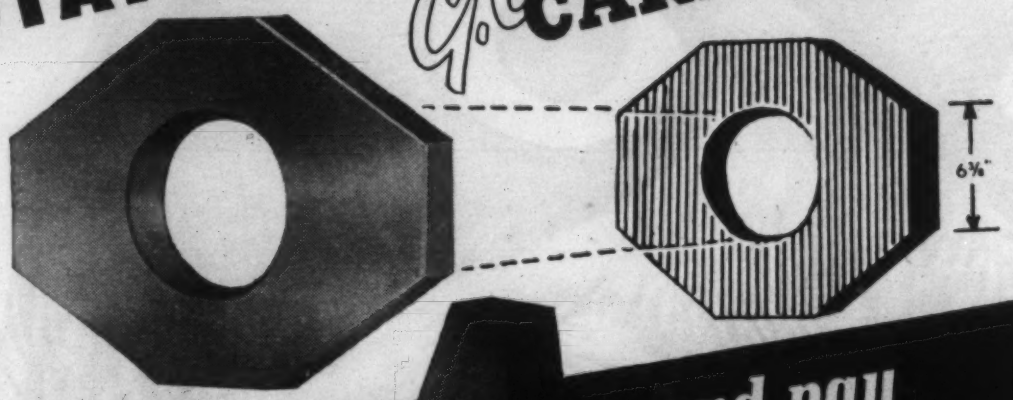
DETROIT 14, MICHIGAN

World's largest producer of small-diameter tubing

AFFILIATED PLANTS IN ENGLAND, FRANCE AND GERMANY



when you buy PATTERN CUT STAINLESS PLATE from G. O. CARLSON, INC.



You reduce your cutting costs

and pay no freight on scrap material

Type 304—Abrasive cut edges; machined faces. Weight 69 lbs.

Why waste expensive labor cutting odd shapes of stainless with improvised tools—when you can get just what you want from G. O. Carlson, Inc. cut to shape by our specialized equipment? And don't overlook the high cost of shipping unnecessary scrap material, which is eliminated.

More and more fabricators are saving money and time by "letting Carlson do it"—which means one order for plates to size, one handling, and when the plates are delivered, they are ready for final finish work.

Stainless steels to chemical industry standards are our only business, and the powder cutting, abrasive cutting, rough machining, and sawing techniques we use are regular added services which our customers depend on for cutting costs to the bone.

Carlson distributors are located in practically every metropolitan area. If you do not know your local source, write to us. If it is a rush order, send details direct. You can depend on G. O. Carlson, Inc. for unparalleled service in Stainless Steels.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

Warehouse distributors in principal cities

New Materials and Equipment

nace, and the transfer from the furnace to the cooling or quenching section is accomplished without breaking the atmosphere seal.

Cleaning & Finishing

Sandblast Cleaning Cabinet

A new sandblast cabinet for cleaning dies, tools, pistons, piston rings, valves, and other small parts has been announced by *W. W. Sly Manufacturing Co.*, 4700 Train Ave., Cleveland 2.

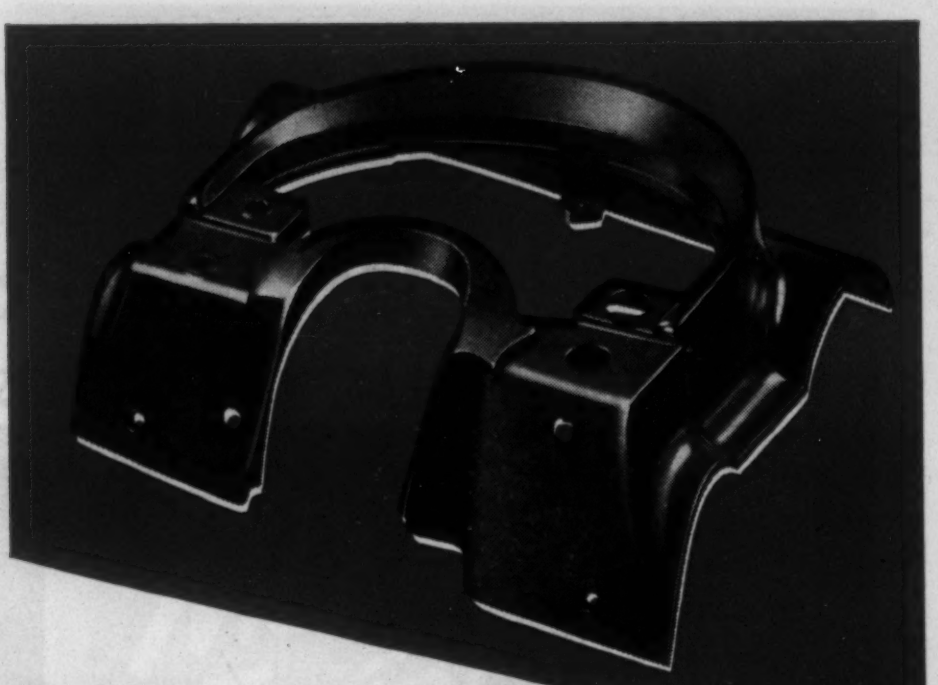
Designed for cleaning small metal parts by the use of soft abrasives, such as ground

This 14- by 17-in. sand blast cleaner is designed for cleaning dies, tools, piston rings, valves and other small parts.

corn cobs or ground nut shells, the cabinet is said to thoroughly remove all surface impurities without scoring the metal. It can also be used with either sand or metal abrasives.

Measuring 14 by 17 in., the new unit can be placed on a work bench, connecting it to a compressed air line and to a 110-v lighting circuit for the lights and the exhaust fan. It comes complete with two light fixtures for illuminating the interior, an exhaust fan and a dust bag.

You're always right with AUTO-LITE Die Castings



● Many of America's leading manufacturers, producing a wide variety of products, are benefiting from Auto-Lite die cast research, experience and advancement. Such developments as high pressure casting, special alloying practices and improved quality through the "controlled metals process" make Auto-Lite the logical source of supply for precision die castings. Address inquiries to:

THE ELECTRIC AUTO-LITE COMPANY

Die Casting Division
Woodstock, Illinois

Lockland Division, Cincinnati 15, Ohio

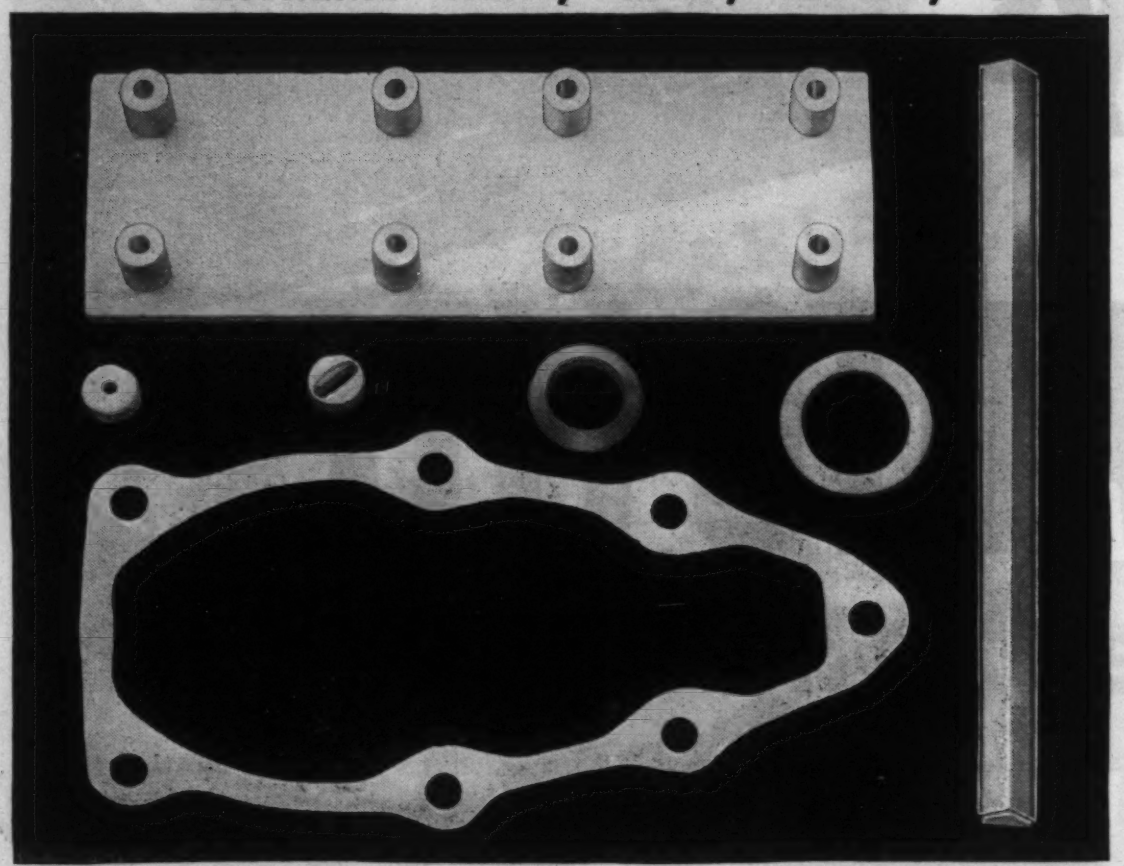
600 So. Michigan Ave. Chicago 5, Illinois
723 New Center Bldg. Detroit 2, Michigan

Tune in "Suspense!"... CBS Radio Thurs.... CBS Television Tues.

DIE CASTINGS • WIRE & CABLE • PLASTICS • INDUSTRIAL THERMOMETERS

SILICONE RUBBER Parts

RESIST EXTREME HEAT, COLD, FLUIDS, GASES



Silicone rubber is a solution to problems involving rubbery properties at abnormally high and low operating temperatures. Under these conditions it performs successfully beyond the scope of any known rubber or rubber-like materials, and meets the requirements of extreme temperature applications in the aviation, automotive, electrical, refrigeration and original equipment manufacturing industries.

At extreme temperatures −100°F to +500°F Silicone rubber parts remain resilient, with improved compression set. General qualities include; excellent stability after long exposure to ultraviolet rays, prolonged weathering, fungus growth, many oils and a variety of chemicals; excellent dielectric properties, and water repellency; stainless; odorless; bonds to metal.

Seals, gaskets, O-rings, packings, diaphragms and numerous parts can be produced from Silicone stocks.

Send for Rubber Handbook on your company letterhead

Acushnet
PROCESS COMPANY
New Bedford, Mass., U. S. A.

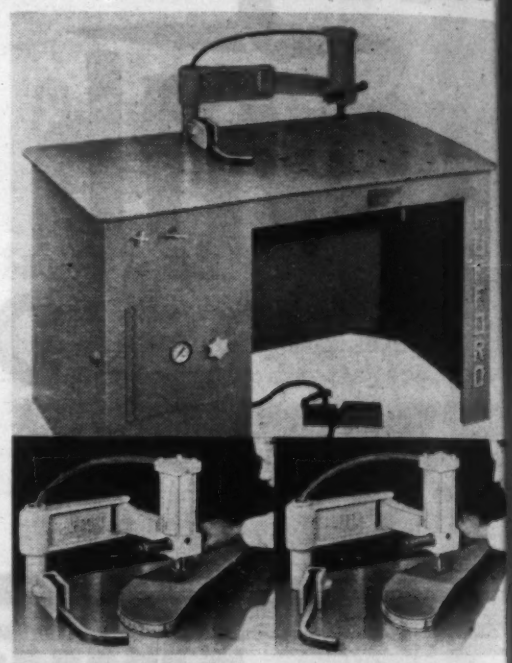
Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment

Finishing Machines

Two new finishing machines designed for easing the manufacture of sheet metal parts have been developed by *Hufford Machine Works, Inc.*, 207 N. Broadway, Redondo Beach, Calif.

The first of the two machines, the Hufford shrink finishing machine, is said to remove wrinkles from those parts formed on rubber pad presses which commonly occur when an edge is turned and the sheet metal placed in compression. Previously, these wrinkles had been removed by a manual operation.



These new finishing machines are designed to speed up finishing operations and to permit the use of female labor.

After the shrinking operation, the work and form block are taken to the Hufford planishing machine which incorporates an air-driven hammer assembly mounted on a smooth table top. The hammer is activated by pressure of the work against the head itself, and a series of short, rapid blows quickly removes minor defects, producing a smooth finished surface.

Steam Cleaning Gun

Developed for use in heavy-duty steam cleaning operations, a new steam gun, Model 502 Oakite solution-lifting steam gun, has been announced by *Oakite Products, Inc.*, 22 Thames St., New York 6.

Weighing 15¾ lb, 7½ ft long, and equipped with two cast aluminum spade-

Regardless of . . .

SIZE, SHAPE, or WEIGHT

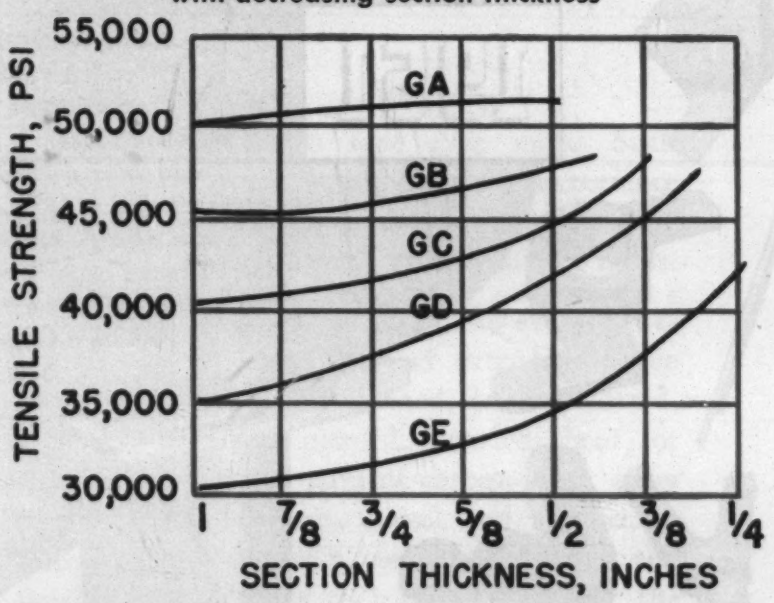
You can depend on MEEHANITE Engineering Properties!

The group of small lightweight Meehanite castings illustrated are typical of both the variety and importance of thousands of similar small casting specifications regularly met by many Meehanite foundries. While giant, heavy weight castings are spectacular and, of course, important too, many a vital component of important equipment lies hidden;—those small parts weighing from a few ounces to a few pounds yet whose properties and qualities must be both exact and uniformly superior.

Meehanite castings large or small are manufactured using definite and established process controls. These controls permit the regular meeting of property specification such as strength, hardness, modulus of elasticity or resistance to wear, heat and corrosion, according to the combination of characteristics required.

These same property controls aid in the ability to minimize mass influence as revealed in the chart shown.

Graph showing change in tensile strength with decreasing section thickness



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CONSULT ANY OF THE FOUNDRIES LISTED BELOW

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The American Laundry Machinery Co. . . . . Rochester, New York
Atlas Foundry Co. . . . . Detroit, Michigan
Banner Iron Works . . . . . St. Louis, Missouri
Barnett Foundry & Machine Co. . . . . Irvington, New Jersey
E. W. Bliss Co. . . . . Hastings, Mich. and Toledo, O.
Builders Iron Foundry . . . . . Providence, Rhode Island
Continental Gin Co. . . . . Birmingham, Alabama
Crawford & Doherty Foundry Co. . . . . Portland, Oregon
The Cooper-Bessemer Corp. . . . . Mt. Vernon, Ohio and Grove City, Pa.
Farrel-Birmingham Co., Inc. . . . . Ansonia, Connecticut
Florence Pipe Foundry & Machine Co. . . . . Florence, New Jersey
Fulton Foundry & Machine Co., Inc. . . . . Cleveland, Ohio
General Foundry & Manufacturing Co. . . . . Flint, Michigan
Greenlee Foundry Co. . . . . Chicago, Illinois
The Hamilton Foundry & Machine Co. . . . . Hamilton, Ohio
Johnstone Foundries, Inc. . . . . Grove City, Pennsylvania
Kanawha Manufacturing Co. . . . . Charleston, West Virginia
Lincoln Foundry Corp. . . . . Los Angeles, California
E. Long Ltd. . . . . Orillia, Ontario
Otis Elevator Co., Ltd. . . . . Hamilton, Ontario
The Henry Perkins Co. . . . . Bridgewater, Massachusetts
Pohlman Foundry Co., Inc. . . . . Buffalo, New York
Rosedale Foundry & Machine Co. . . . . Pittsburgh, Pennsylvania
Ross-Meehan Foundries . . . . . Chattanooga, Tennessee
Shenango-Penn Mold Co. . . . . Dover, Ohio
Standard Foundry Co. . . . . Worcester, Massachusetts
The Stearns-Roger Manufacturing Co. . . . . Denver, Colorado
Traylor Engineering & Mfg. Co. . . . . Allentown, Pennsylvania
Valley Iron Works, Inc. . . . . St. Paul, Minnesota
Vulcan Foundry Co. . . . . Oakland, California
Warren Foundry & Pipe Corporation . . . . . Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

MEEHANITE® NEW ROCHELLE, N. Y.

Microcast®

Cavalcade

The phenomenal growth and acceptance of the MICROCAST PROCESS within the short space of 22 years indicates only a bare surface-scratching to date of its potential development. Those small beginnings in the dental and surgical appliance field, hastened by wartime demands, paved the way for eventual industrial application.

Today, MICROCASTINGS are in the forefront of civilian and military manufacture. A new industry has developed, daily solving new problems and making possible the economical production of millions of small parts in many fields. And as the requirements for the future begin to manifest themselves, it is a safe bet that the MICROCAST PROCESS will be a leader, helping to make better things *better* and at *lower cost*.

MICROCAST PRECISION CASTINGS PROCESS

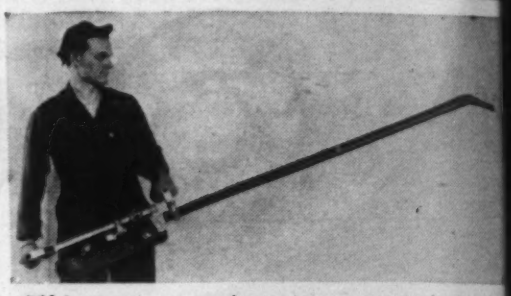
MICROCAST T. M. REG. U. S. PAT. OFF.

GET OUR STORY! Write for fully illustrated 16-page booklet describing the Microcast Process. Specifications, technical information, and a step-by-step explanation. Do it today!

MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
224 East 39th Street • New York 16, New York
715 East 69th Place • Chicago 37, Illinois

New Materials and Equipment

type insulated handles, the gun is designed for use where range of operating pressure (psi at boiler end of hose while gun is in use) is 50 to 100 psi with minimum



This steam gun features a reinforced rubber apron backing up the steam valve and other hot fittings to protect the operator from contact burns.

boiler rating of 25 or more horsepower recommended.

An outstanding advantage claimed for the new gun is that detergent spray is automatically lifted 12 ft above the working level, which provides a thorough cleaning of large equipment and other surfaces.

Welding & Joining

Solder for Aluminum

Intended as a quicker, lighter and more economical metal fill for the filling of aluminum die castings, a new product, Fil-Soder, is being marketed by *Swiss Laboratory*, Cleveland 14.

Said to be the most modern method of metal filling, with strong possibility of revolutionizing old established soldering practices, this new product is a metal blend made in combination with tin and lead.

Some of the advantages claimed for the new metal blend are:

1. Requires no fluxing—takes 70% less heat for a fast firm fill and feathers to a smooth invisible edge.
2. Will not shrink or pinhole.
3. Retains heat longer than ordinary solder.
4. Because of its low melting point, it does not warp metal, yet it can take 180 F infra-red bake.

Fil-Soder comes in ⅜-in. round extruded 12-in. bars of amazingly light weight, actually only about 25% the

Townsend

Saves Customer $12,000 In One Year With This Cold Headed Part

There may be several parts you are now using that Townsend can produce for you by cold-heading at substantial savings just as we did for a mid-west washing machine manufacturer. Originally the wringer spring rod shown above cost them $33.40 per thousand. Then a Townsend engineer suggested a change in design which eliminated one complete step in the manufacturing operation. This simple change reduced the cost to $20.95 per thousand—a clear savings of $12.45 per thousand. On an annual basis they save more than $12,000 on this part alone.

Savings like this are not unusual with Townsend customers—this is a typical example —some manufacturers save even more. Such economy is a reflection of the size and experience of the Townsend organization and demonstrates the possibilities for savings even on simple items.

Townsend makes 60 million items every working day by cold-heading and extruding—then they may be pointed, machined, drilled, slotted, trimmed, threaded, pierced, knurled, bent, or flattened. We make parts of carbon steel, alloy steels, bronze, copper, monel and aluminum. These are supplied in a variety of platings and finishes. If you want to learn more about the economy of cold-heading by Townsend ask to have one of our engineers call.

Townsend

COMPANY • ESTABLISHED 1816

Plants—New Brighton, Pa. · Chicago 38, Ill.

Cherry Rivet Company Division, Los Angeles, California

Sales Offices in Principal Cities

No. 50—Product of
Barber-Colman Company
Rockford, Illinois

The precision response of this Chace Thermostatic Bimetal blade "shaves" room temperature differentials to 1°F! The thermostat is Barber-Colman's Microtherm, used with their motor-operated proportioning valves or damper control motors; it contains a solenoid which positions these control units in accordance with heat demand.

Low room temperature moves the contact-carrying bimetal toward contact "A". This closed circuit causes the motor to rotate the unit toward "full open" position and moves a rheostat arm, positioned from the final drive shaft, toward its maximum voltage. The rheostat energizes the solenoid "B", which pulls the blade away from the top contact before rising temperature causes bending of the bimetal. The fully energized solenoid pulls the blade to the lower contact "C", reversing rotation of the unit toward closed position. The rheostat then reduces voltage to the solenoid, thus reducing its pull on the bimetal blade, which can now move upward as temperature lowers, beginning another cycle.

Chace furnishes this element completely fabricated, ready for installation in the thermostat. Chace Thermostatic Bimetal is also available in strips, coils, random long lengths and welded or brazed sub-assemblies. Ask the Chace Application Engineer which of these forms will best fulfill *your* thermostatic bimetal requirements.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

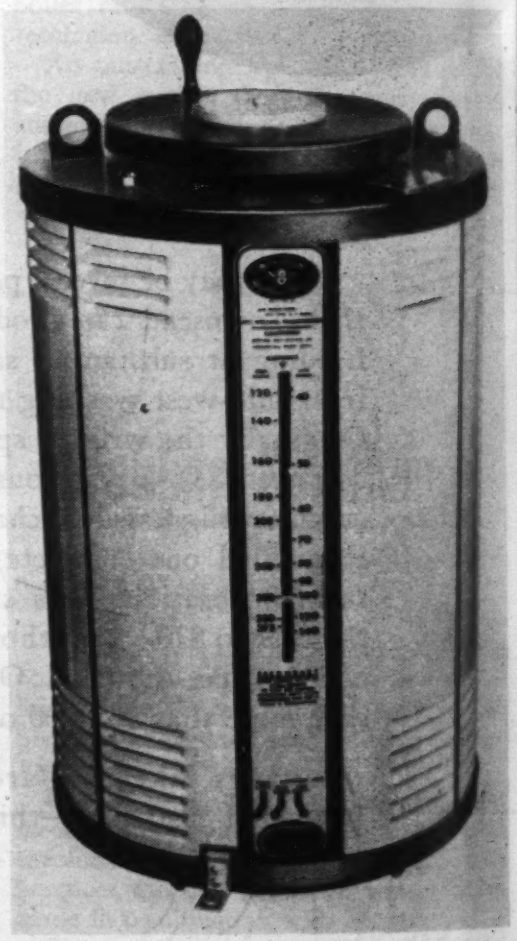
New Materials and Equipment

weight of ordinary solder. Yet it is claimed that two bars of Fil-Soder will fill as much as a pound of 30% bar solder, and cost less than even 15% solder.

Transformer Arc Welders

New 300-, 400- and 500-amp Wilson Bumblebee arc welders, available as indoor or all-weather models, have been announced by *Air Reduction Sales Co.*, division of *Air Reduction Co., Inc.*, 60 E. 42nd St., New York 17.

All models are said to have the sturdy construction, compactness and light weight



This new transformer arc welder features sturdy construction, compactness and light weight.

so important to high-quality, economical welding. Outstanding features include instant arc-starting, wide current range, easily operated control and minimum maintenance.

Automatic hot-start control with arc-stabilizing capacitors are provided on the 300- and 400-amp models. Current ranges are 60-375 for the 300-amp model, 80-400 for the 400, and 100-675 for the 500.

Silicone insulation is claimed to provide

TINNERMAN

Speed Nut

SAVINGS STORIES

ROUGH

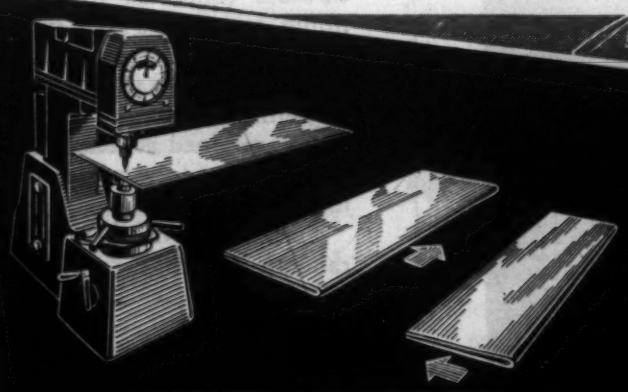
ON RAW MATERIALS

Quality of materials has a lot to do with the quality of fasteners produced for your products. That's why every coil of spring steel, every shipment of finishing paints and chemicals and every material required for the manufacture of SPEED NUTS is subjected to rigid "entrance exams."

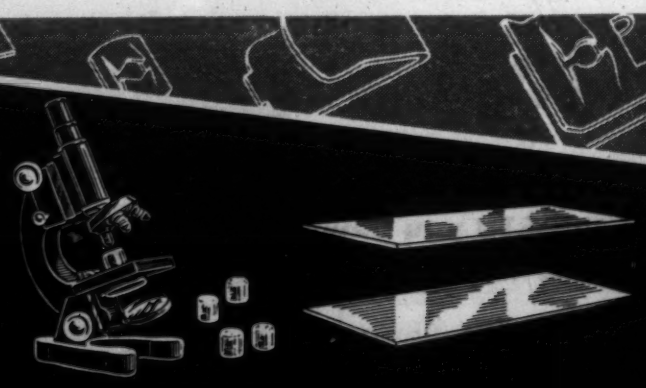
The primary raw material, steel, gets the most intensive checkout. Four laboratory procedures must be conducted on samples from every steel lot. Bend Test; Metallographic Analysis; Heat-Treat Cycle Test; and Thickness Tolerance Test.

Raw materials testing is Stage One in Tinnerman's program to guarantee you highest quality SPEED NUT brand fasteners for all types of attachments. Follow your fasteners through all stages of Tinnerman quality control . . . write for your copy of "Story of Quality", new 20-page booklet.

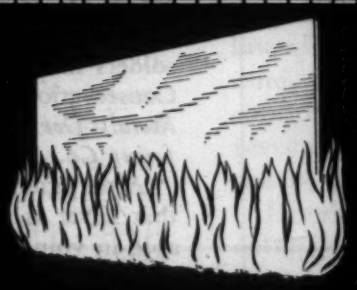
TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio. In Canada: Dominion Fasteners Ltd., Hamilton. In Great Britain: Simmonds Aerocessories, Ltd., Treforest, Wales.



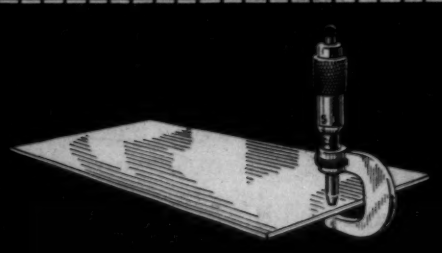
HARDNESS AND BEND TEST—Hardness is checked to insure against fracturing; then samples are bent 180° in two directions to determine ductility.



METALLOGRAPHIC ANALYSIS—Microscopic inspection determines internal structure of samples mounted in plastic for examination.



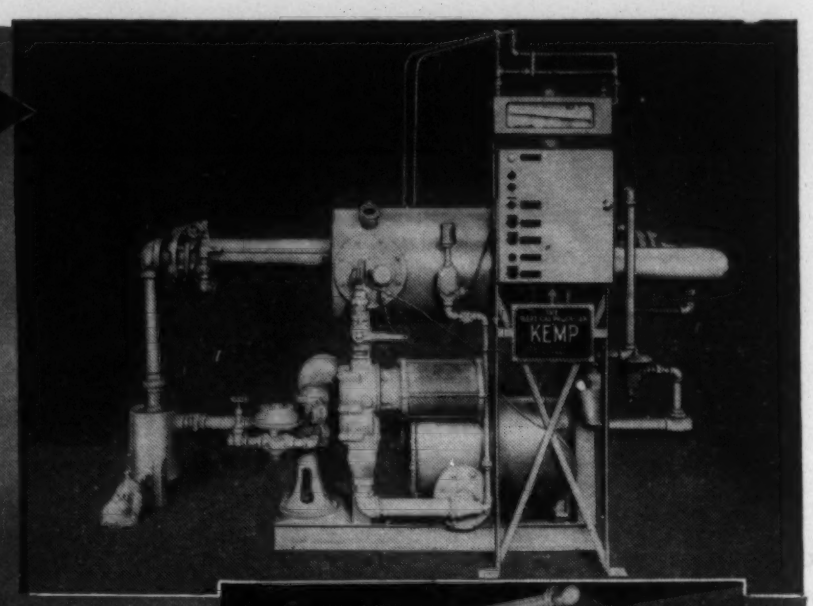
HEAT TREAT CYCLE TEST proves capacity of samples to harden and draw to spring steel qualities.

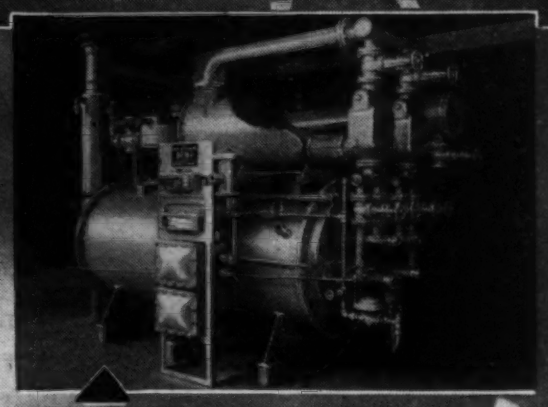


THICKNESS TOLERANCE TEST—All steel received is subjected to minute dimension checks to maintain rigid tolerance requirements.

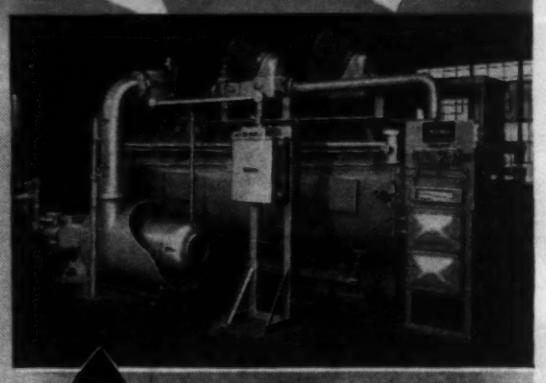
TINNERMAN Speed Nuts®

Model 1 MIHE offers all the features of larger equipment . . . delivers 1000 cfh ...is fully automatic.





Model 6 MIHE is ideal for agitating, bubbling and blanketing in synthetic resin plants . . . delivers 6000 cfh.



Model 60 MIHE produces 60,000 cfh . . . is widely used for purging and blanketing in the petroleum industry.

It pays to GENERATE your own INERTS

Kemp Inert Gas Generators Save $9 of the $10 you now spend for Inerts

Need inerts for purging, fire protection, mixing, blanketing or a special application? You can save up to 90% on Inert Gas costs when you generate your own inerts with a Kemp Inert Gas Producer. The cost of transportation, bottle juggling, storage, deposits on cylinder inventories and the initial higher cost of bottled nitrogen or CO_2 is eliminated.

ABSOLUTELY DEPENDABLE

No matter what the demand, Kemp Inert Gas Generators give you the same analysis Inert Gas from 20% to 100% of capacity. The Kemp Industrial Carburetor, part of each installation, burns ordinary gas just as it comes from the mains. Assures complete combustion without "tinkering." Produces a clean, chemically inert gas to meet your most exacting requirements.

SEND FOR DATA

Whatever your requirements, always specify Kemp. *To find out how you can benefit:* Tell us your atmosphere gas problem, and we'll show you how Kemp can solve it and save you money!

KEMP OF BALTIMORE

INERT GAS GENERATORS

Write for Bulletin I-10 for technical information C. M. KEMP MFG. CO. 405 E. Oliver St., Baltimore 2, Md.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • METAL MELTING UNITS • SINGEING EQUIPMENT • SPECIAL EQUIPMENT

New Materials and Equipment

two-way safety: it operates safely at high temperatures without breaking down, and it is water repellent. Also, the light weight resulting from the use of silicone insulation makes these models ideal to mount on running gear for portability.

Hard Facing Rod

Production of a new oxyacetylene welding rod for hard facing against medium impact and high abrasion has been announced by *Alloy Rods Co.*, 8205 W. Market St., York, Pa.

Known as Wear-Flame 40, the new part is a centrifugally cast hard facing rod consisting of highly wear resistant chromium carbides contained in a hard iron chromium, manganese alloy matrix.

Wear-Flame 40 overlays are said to offer a high resistance to wear parts subjected to medium impact and compression. Hardness is retained at relatively high temperature, and hardness of deposited metal is 56 to 58 Rockwell C.

Sizes are available in 1/8-in. dia by random lengths, 5/32- to 3/8-in. dia by 14-in. lengths.

Tin-Conserving Solder

Development of a group of solders which are said to permit savings of 50% or more in the tin normally used for solders has been announced by the Metals Conservation Committee of the *Federated Metals Div., American Smelting and Refining Co.*, 120 Broadway, New York 5.

After extensive research, results indicate that silver is the only metal readily available in volume that can be substituted for part of the tin in solder. According to the Committee, there is virtually no loss in working efficiency, and cost is less than that of the alloys replaced.

The new tin-conserving, ST solders are basically silver-tin-lead alloys as compared with the usual tin-lead variety. Addition of a small percentage of silver is claimed to permit a marked reduction in the tin content, at the same time giving a joint at least as good as that given by the original alloy.

In the joining of sheet metal it is said that the new ST-30 (30% tin) solder will perform as well as the commonly used 50 tin-50% lead or 40 tin-60% lead solders. The Committee asserts that in general, where 35/65 is used in the soldering of end

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

In the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributors: Bethlehem Steel Export Corporation

150,000 Stainless Spoons from Striking Dies of XX Carbon

shaping of stainless steel can be a ky job. A leading cutlery maker, faced new problems in starting the pro- tion of stainless flatware, asked Beth- m to recommend a tool steel suitable striking dies. (The master dies are d-engraved by craftsmen in the tra- onal fashion of this intricate art.) he manufacturer adopted our recom- dation of Bethlehem XX Carbon l Steel for this difficult operation. ults have been highly satisfactory. ons and other flatware are struck quantities exceeding 150,000 pieces from one impression of the striking dies.

XX Carbon Tool Steel offers many advantages for general-purpose tools and dies. It's easy to machine and heat-treat; it develops a hard case, reinforced by a tough, shock-resisting core; it holds a keen cutting edge; it's economical; and there's a range of carbon content to meet many different requirements.

We closely control the hardenability of this grade, and give it a careful and uniform spheroidize-anneal. Bethlehem Carbon Tool Steels are the kind you can rely on for top performance.

Our Tool Steel Engineer Says:

Use thermocouple when you pack-harden tools

enever tools are pack-hardened (to nce the scaling and decarburization) e a thermocouple *in the pack* against tools so that the time the *tools* are at t can be determined accurately.

ecently a 34-in.-diameter die ring of Lehigh H (high-carbon, high-chro- m) Tool Steel was pack-hardened by experienced heat-treater. Treatment pleted, he checked the hardness and flabbergasted to find that he had ob- ed a hardness of only Rockwell C-48. n he checked his pyrometer charts ch proved, he thought, that he had owed the recommended heating cycle. y the low hardness?

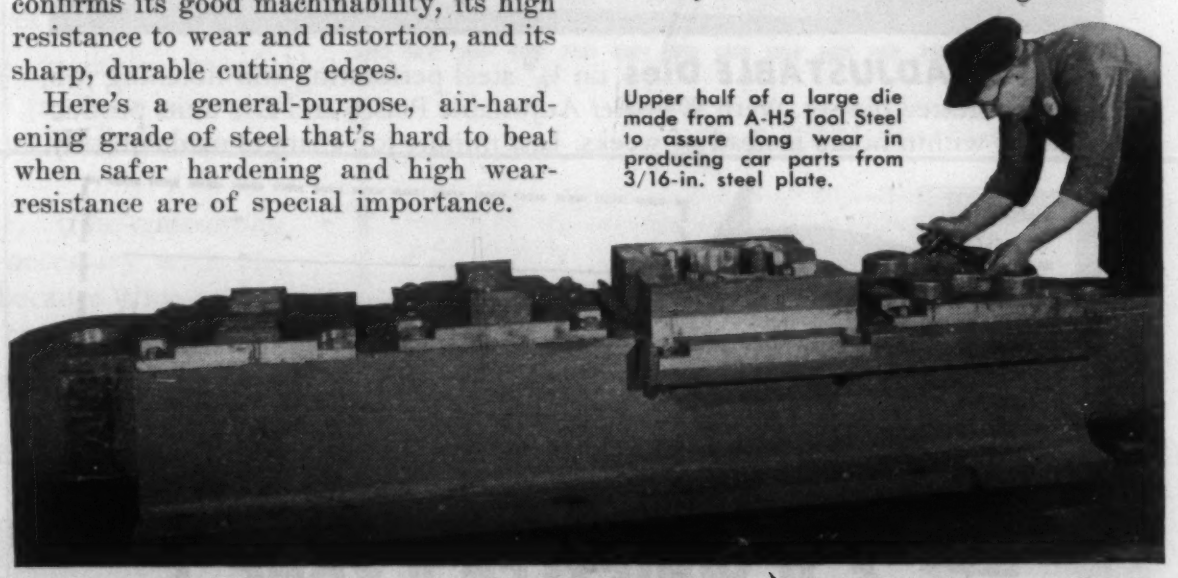
Bethlehem trouble-shooter suggested t he insert a thermocouple in the pack inst the ring. He did so, and this time a hardness of Rockwell C-60—prov- that in the first treatment the die ring n't heated long enough to reach the per temperature, even though the rds of the furnace heating cycle ap- red to indicate correct treatment.

BIG DIE OF A-H5 MAKES CAR PARTS

A massive die produces spring plates from 3/16-in. steel plate for hopper cars, at the Berwick, Pa., plant of American Car & Foundry. All wearing surfaces of the die, which performs a punching, blanking, and forming operation, are made of A-H5 Tool Steel.

This leading car-builder uses this 5-pct-chromium, air-hardening tool steel to produce car parts from carbon steel, low-alloy high-tensile steel, and aluminum. A.C.F.'s experience with A-H5 confirms its good machinability, its high resistance to wear and distortion, and its sharp, durable cutting edges.

Here's a general-purpose, air-hardening grade of steel that's hard to beat when safer hardening and high wear-resistance are of special importance.



Upper half of a large die made from A-H5 Tool Steel to assure long wear in producing car parts from 3/16-in. steel plate.

Prompt shipment to our distributors is made possible by our modern tool-steel depot at Bethlehem, Pa. Complete sizes of 23 different grades are stocked.

Tool Steel Distributors Give Service in a Hurry

Delivering tool steel in a hurry is only one of the many services performed by the distributor. He knows local requirements, and he carries large stocks of the tool steel grades and sizes that his customers are most likely to require. He's ready at any time to go into action to see that your tool steel needs are taken care of, whether it means cutting bars to exact size or lending a hand in recommending the kind of heat-treatment you'll need.

Having a tool-steel distributor in your neighborhood makes it unnecessary for you to carry large inventories of tool steel . . . and he often carries other steel specialties that you use frequently.

Distributors of Bethlehem Tool Steels are reputable, experienced firms. They render a real service in all parts of the country. We are proud to have them so closely linked with our sales organization.

Bethlehem ULTRASONIC TESTED **Tool Steel**

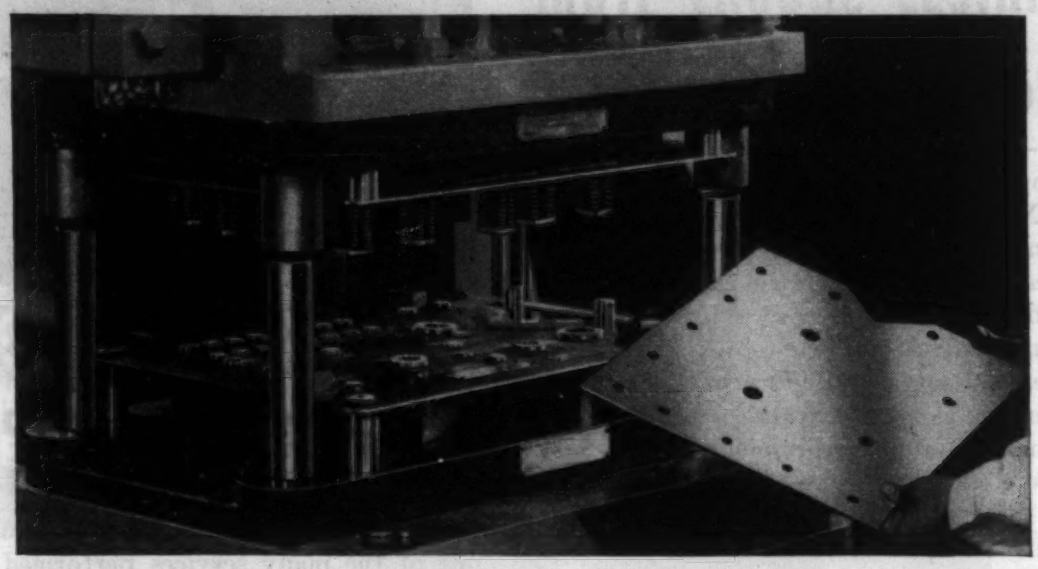
New • Fast • Proven

LOW COST

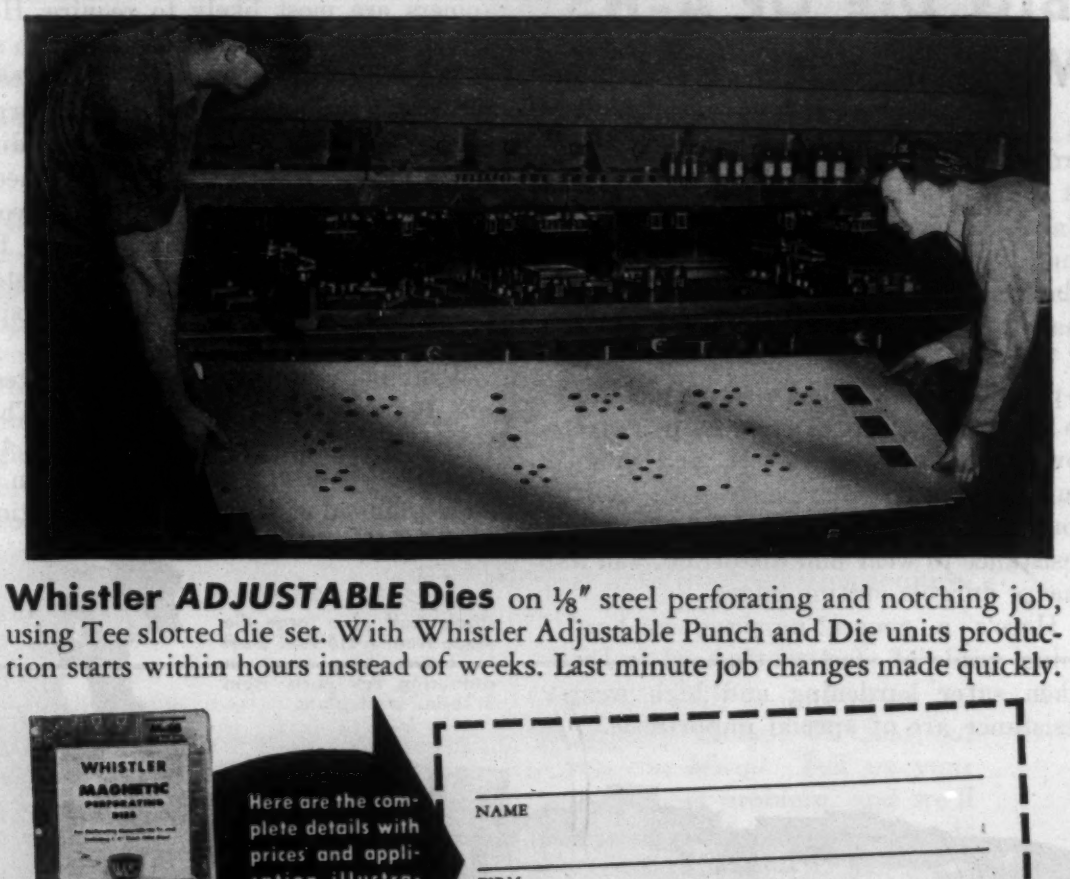
methods for PERFORATING and NOTCHING SHEET METALS

Both methods feature: LOW DIE COSTS

All units and parts are interchangeable and used repeatedly in different arrangements. **INCREASE PRESS PRODUCTION** – Down time is minutes as compared to hours for changeover. For precision work in all types and sizes of presses. **START PRODUCTION *at once.*** Pierce up to ¼" thick mild steel. Saving money in the best known plants.



Whistler *MAGNETIC* Dies at work in large inclinable press. Magnetized units hold the retainers. No bolting required. A fast, economical method in making up a punch and die set for short or long runs. All parts re-usable.



Whistler *ADJUSTABLE* Dies on ⅛" steel perforating and notching job, using Tee slotted die set. With Whistler Adjustable Punch and Die units production starts within hours instead of weeks. Last minute job changes made quickly.

Here are the complete details with prices and application illustrations. Send for these catalogs. No obligation.

NAME

FIRM

ADDRESS

CITY ZONE STATE

S. B. WHISTLER & SONS, Inc.

Adjustable, Magnetic, Custom and Cam Dies for all Industry

756 Military Road, Buffalo 23, N. Y.

New Materials and Equipment

seams in can manufacture, ST-25 is satisfactory, while in the case of sealing milk cans, 30/70 is generally used. In radio and television tube manufacture, ST-20N can be used in place of solder with much higher tin content.

While the same flux can be used with the new solders, and the identical means of application can be employed, ST solders do require slightly more heat in order to melt.

Tungsten Electrode

A new tungsten electrode which is claimed to reduce inert-arc welding costs has been announced by the Welding Div. of *General Electric Co.*, Fitchburg, Mass.

Major applications of the new electrode will be for inert-arc welding with direct current, straight polarity using either argon or helium gas. According to GE engineers, this type is usually used to weld mild steel, stainless steel, copper and alloys.

The new Hi-Thoria tungsten electrodes are said to produce a stable arc over a wider range of currents and resist contamination by weld metal, resulting in over ten times normal life.

Hi-Thoria tungsten is claimed to have strength comparable to standard pure tungsten. However, it runs cooler than standard tungsten and does not become molten, hence the end of the electrode remains square and intact, and consumption is reduced.

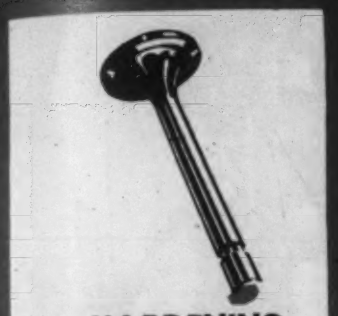
Manufactured in 3- to 24-in. lengths and from 0.040 to ¼ in. in dia, the new electrode is not recommended as a standard tungsten replacement for reverse polarity dc, ac welding or automatic hydrogen welding.

Induction Brazing Machine

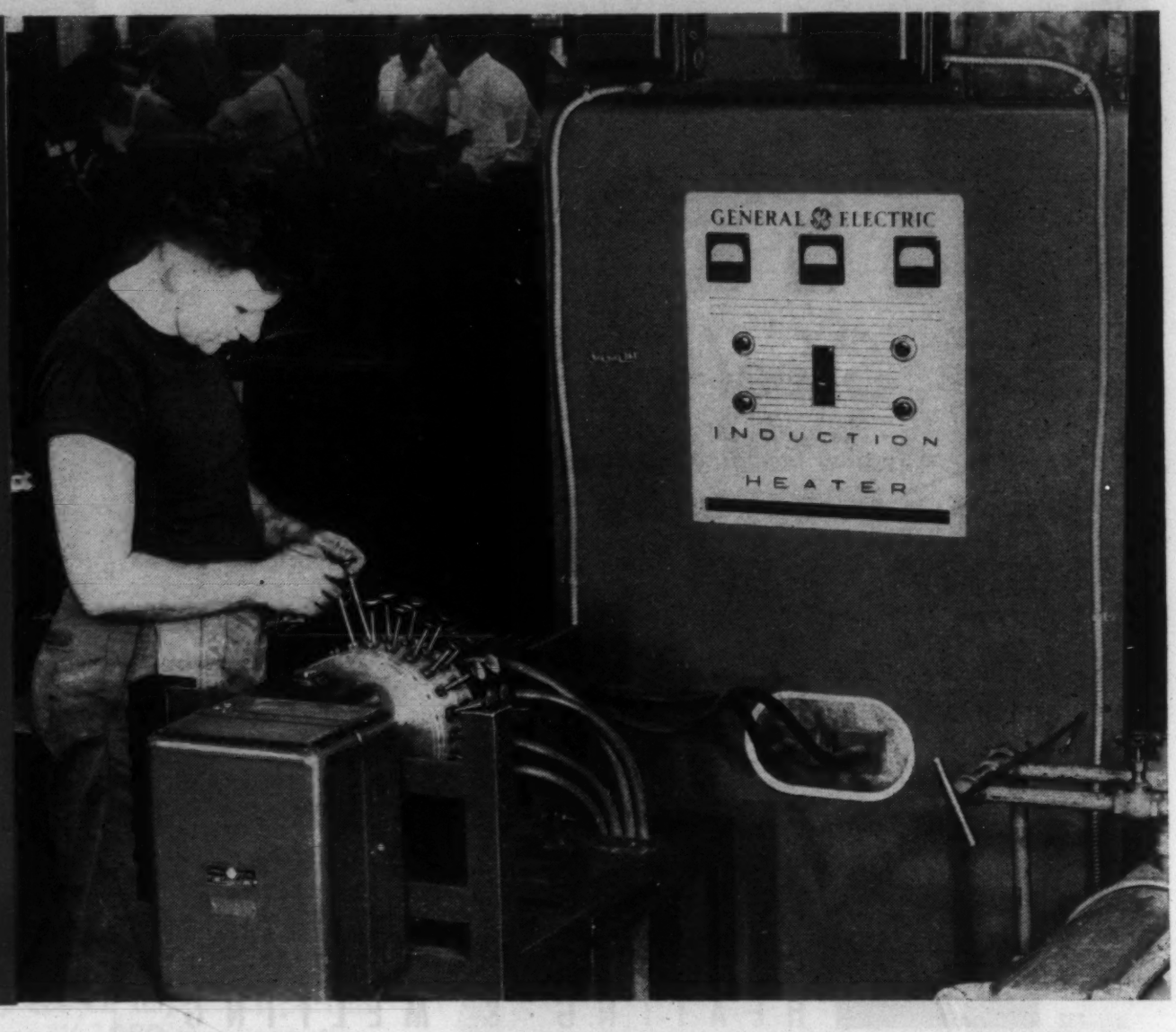
Recently added to the induction heater line of *Sherman Industrial Electronics Co.*, 505 Washington Ave., Belleville 9, N. J. the new induction brazing machine is said to provide quick production setup for brazing, soft soldering or heat treating a wide range of moderate size parts.

With a heavy steel table and an adjustable press type fixture, the machine bolts directly to the front of the company's standard induction heaters. It uses a modified drill press head in which the mecha-

INDUCTION HEATERS



HARDENING VALVE TIPS



Jump Output to 30,000 Valves a Day

When increased demand called for increased production at Thompson Products Company, Cleveland, Ohio, a 20-kw G-E induction heater was put "on the job" hardening valve tips. Equipped with a rotary drum-type handling fixture, this heater increased production to 30,000 valves a day!

Costs Cut 30% By eliminating variables in the treated product, increasing output per man hour and speeding up production, costs on this operation were cut 30%.

Inspection Eliminated Frequent, time-consuming scleroscope hardness inspections necessary with the former method were eliminated because time-under-heat and power input are *exactly* controlled.

Product Improved Thompson Products now achieves consistently uniform case and depth of hardness which has resulted in even better valves.

YOUR PRODUCT and INDUCTION HEATING If you are annealing, brazing, soldering or hardening parts, you can very likely do the job better, faster and at lower cost by putting G-E induction heaters to work in your plant. Just contact the G-E Sales Office nearest you.

General Electric Company, Apparatus Dept.,
Sec. K 720-23, Schenectady 5, N. Y.

SEND FOR YOUR FREE COPY!

"Induction Heating in Industry," GEA-4945, describes how dozens of manufacturers are using induction heat to speed up production and cut costs.

☐ For immediate project ☐ For reference

Name.....

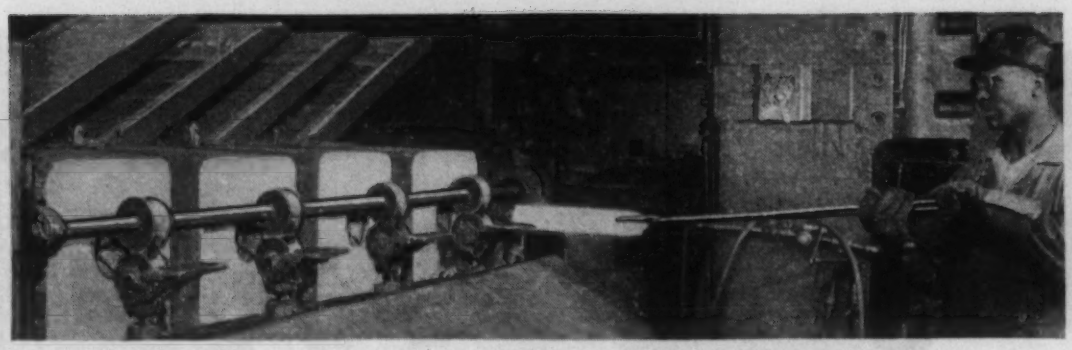
Company.....

Address.....

City..... State.....

You can put your confidence in—

GENERAL ELECTRIC



Save Steel WITH SCALE-FREE AJAX-NORTHRUP HEAT

Billets heated to forging temperature by ordinary methods lose from 2 to 6% of their weight in die-wearing, surface-pitting scale . . . a loss that costs from one to five dollars a ton for most high strength alloys. Ajax-Northrup scale-free induction heating eliminates this waste, and gives you better forging to boot! Send for our technical bulletins today . . . find out for yourself how Ajax-Northrup heating can give you better forgings for less money.

AJAX ELECTROTHERMIC CORPORATION • AJAX PARK • TRENTON 5, NEW JERSEY

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AJAX ELECTRIC FURNACE CORPORATION
AJAX ELECTRIC COMPANY, INC.
AJAX ENGINEERING CORPORATION

AJAX NORTHRUP

HEATING & MELTING

132

One Sure Way to CUT COSTS!

use a

C•F SHEET LIFTER

The A. B. Dick Company, Niles, Illinois, found that this C-F Lifter has substantially reduced man hours and crane time required to move stock in and out of storage.

Up to 10,000 lbs. of high grade sheets in varying widths may be picked up, carried and unloaded at shears or machines with speed and economy by the Lifter and its operator.

C-F Lifters are made in standard or semi-special models to handle from 2 to 60 tons. Bulletin SL-25 describes the advantages you can obtain from C-F Lifters. Write for it today.

CULLEN-FRIESTEDT CO.
1314 South Kilbourn Avenue • Chicago 23, Illinois

New Materials and Equipment

Shown here is a brass candy dish being brazed by the new induction brazing machine.

nism is reversed so that its spring load holds the work part down against an anvil.

Available for operation on 220-v, 60-cycle, single-phase supply lines, the new machine is said to have an output frequency in the megacycle range, and is designed for both steel and brass work.

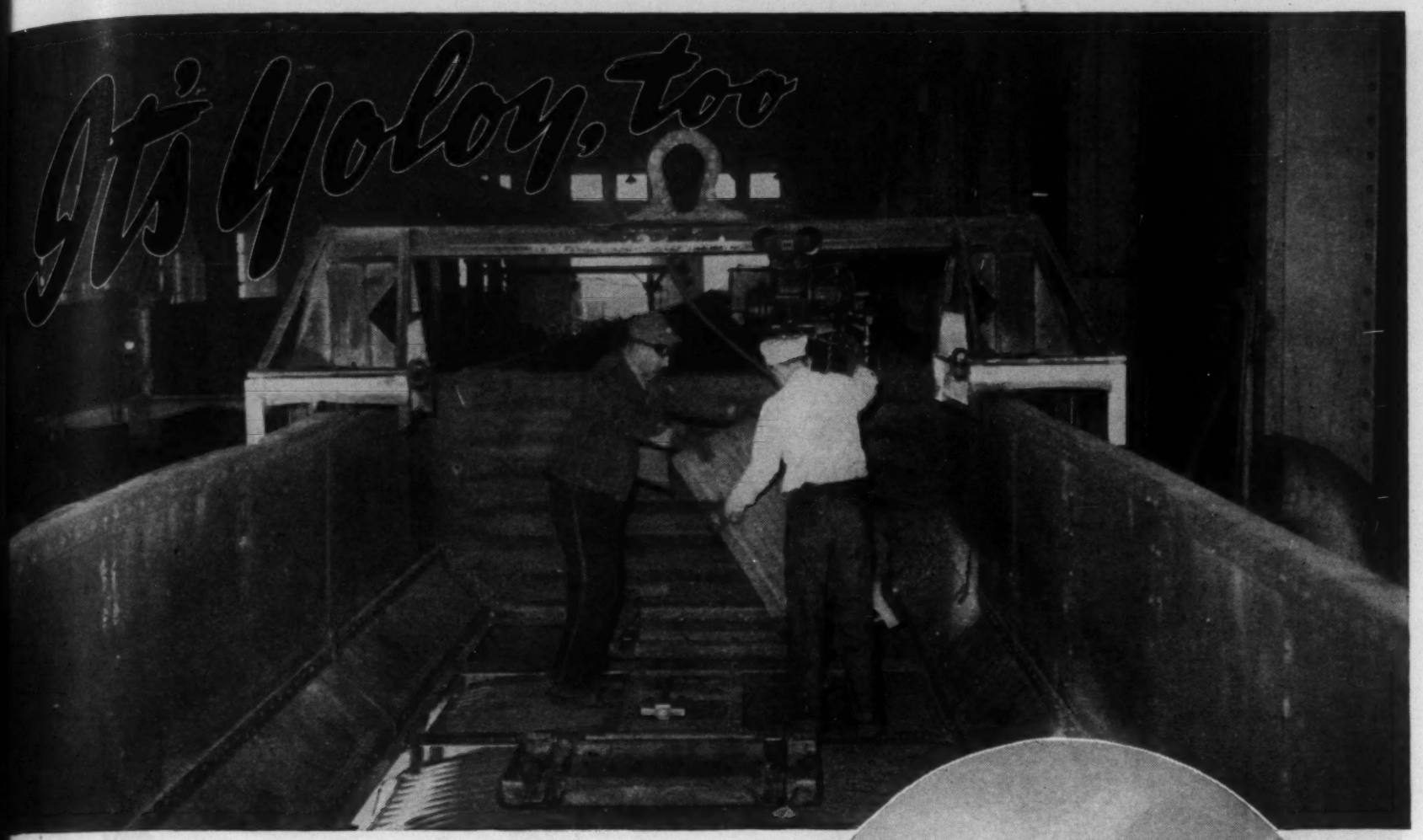
Welding and Brazing Rod

A new cast iron gas welding and brazing rod which employs less of the critical materials, and which can be substituted in some applications for the scarce nickel-base welding alloys, has been announced by *All-State Welding Alloys Co., Inc.*, 273 Ferris Ave., White Plains, N. Y.

Identified as All-State No. 3 cast iron (copper coated) welding and brazing rod, the new rod is recommended as general purpose for both salvage and production, including repairing breaks and cracks, filling blow holes, and building up worn surfaces.

By comparison with other cast iron rods, No. 3 is said to flow out better, make a denser deposit, and machine more easily. Tensile strength is up to 48,000 psi, Brinell hardness 170 to 200, and working temperature 1400 to 1500 F.

No. 3 is applied with All-State No. 1 cast iron flux and a neutral oxyacetylene flame. It does not require melting base metal. Large castings should be entirely pre-heated to approximately 800 F.



for tougher, lighter gondolas

YOLOY steel plays an important part in the Union Pacific Railroad's 1950 car renovation program. Approximately 500 rusty, road-worn gondolas already have been given new life and restored to useful service. All drop doors, which are subjected to severe abrasion and corrosion, are fabricated from Yoloy steel plates.

Yoloy is Youngstown's high tensile low-alloy nickel-copper steel. It has demonstrated a remarkable ability to resist corrosion, abrasion, vibration and shock, even at extreme low temperatures. It also saves weight, due to its extra toughness and strength, welds readily and fabricates easily. It has proved itself in 15 years of service in railroad passenger coaches, box cars, gondolas and other heavy duty equipment.

If you are not yet familiar with Yoloy, ask us for further information. Our District Sales Office nearest you is ready to serve you promptly.

Photographs by courtesy of the Omaha shops of the Union Pacific Railroad.

THE YOUNGSTOWN SHEET & TUBE CO. 1900 YOUNGSTOWN 1950 50 YEARS OF SERVICE

Youngstown
YOLOY STEEL

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices — Youngstown 1, Ohio

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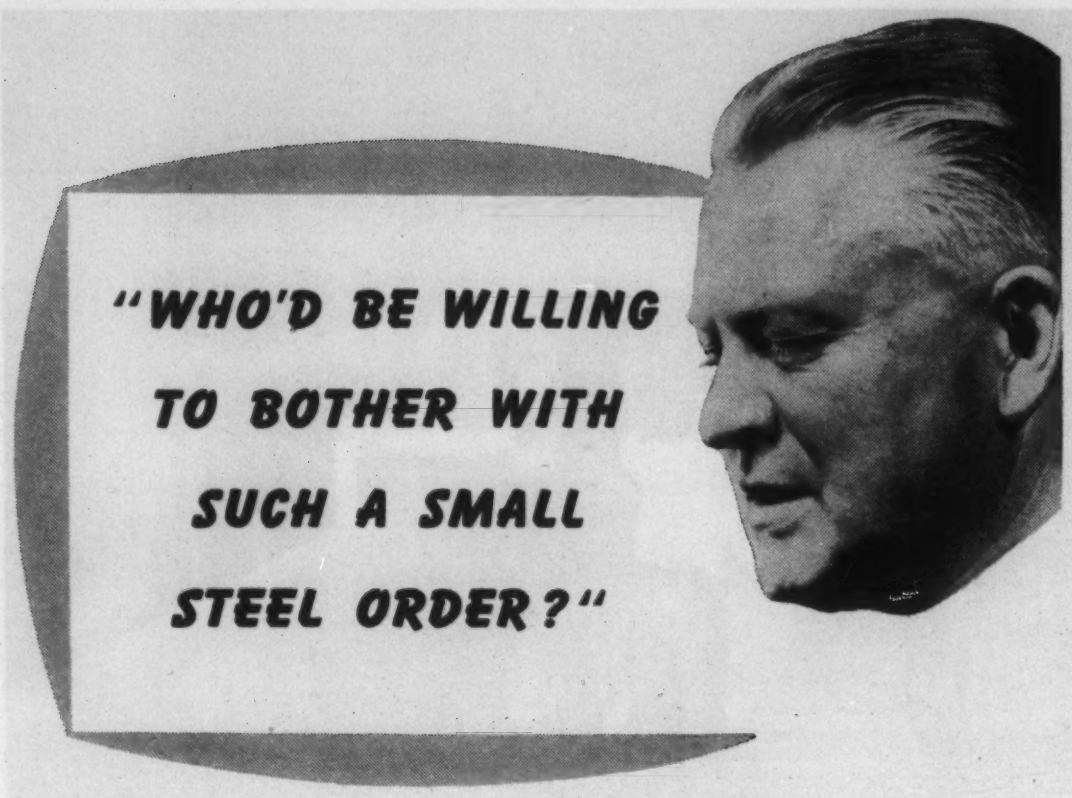

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USS

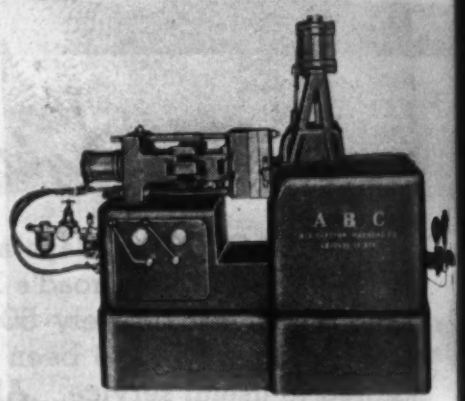
UNITED STATES STEEL

New Materials and Equipment

Forming & Machining

Zinc Die Casting Machine

The *A.B.C. Die Casting Machine Co.*, 339 W. 112th Place, Chicago 28, has announced a new air-operated zinc die casting machine with completely automatic cycling and adjustable timing dwell on the opening and closing of the toggle and injection of the molten metal.



This A.B.C. die casting machine is primarily designed for economical single cavity dies.

According to the manufacturer, the machine will produce castings up to 1 lb in capacity, utilizing die blocks from 1½-in. thickness by 8 by 10 in., with an allowable increase in die thickness up to 3 in. for each half.

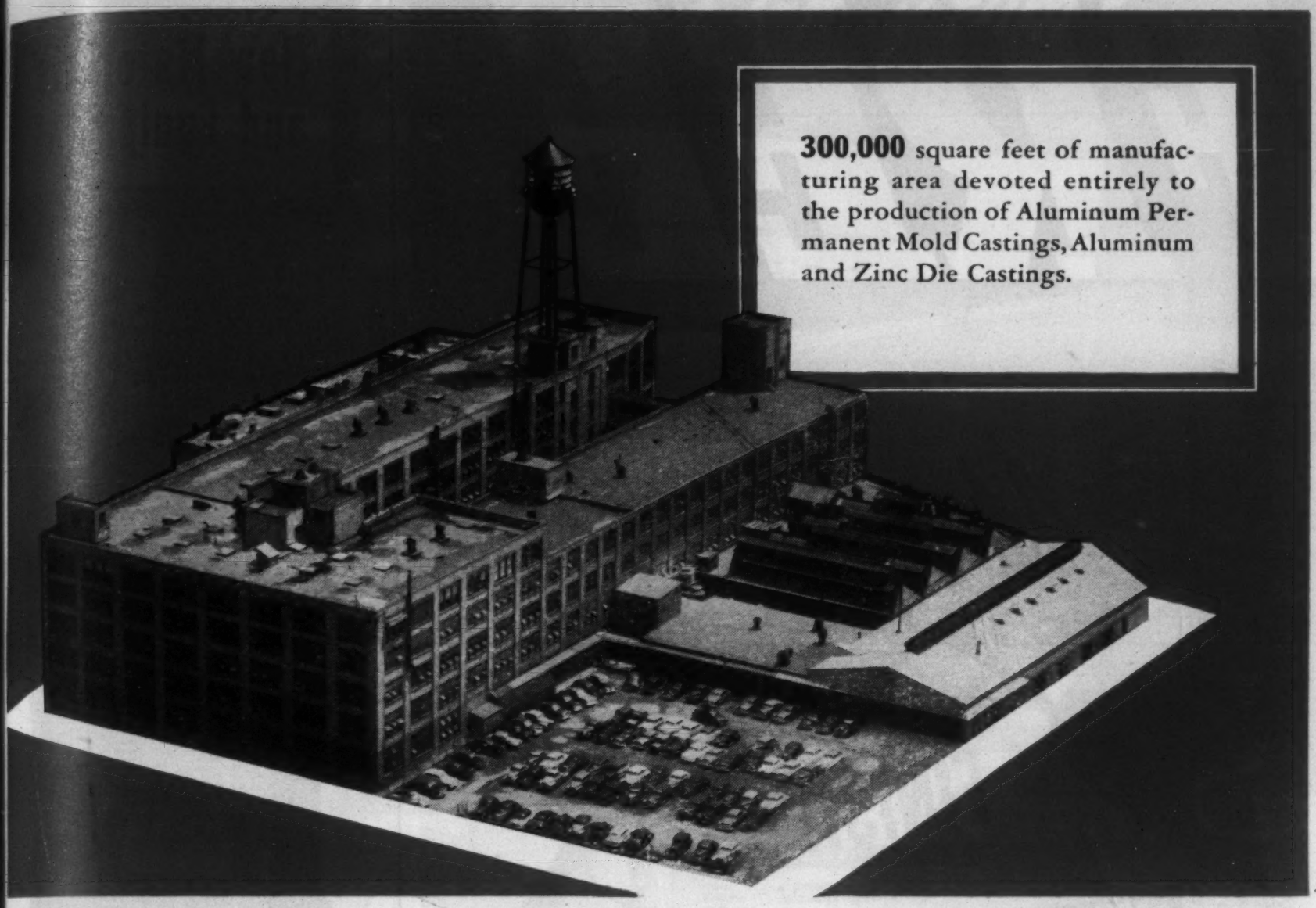
Equipped with a 200-lb pot and of rugged construction, the new unit is capable of a free cycling speed beyond 1000 shots per hr.

Eccentric Presses

Development of a new line of two-point eccentric presses for general-purpose blanking, forming and drawing has been announced by *E. W. Bliss Co.*, Canton, Ohio.

To withstand the most severe operating conditions, the two main gear eccentric units of the new presses are designed with unusually heavy sections and are mounted on and keyed to large diameter shafts. Torsional and axial deflections are said to be practically eliminated by having the shafts revolve in crown bushings, while maximum rigidity is achieved through use of short uprights and deep crown sections.

Another feature of the presses is that


300,000 square feet of manufacturing area devoted entirely to the production of Aluminum Permanent Mold Castings, Aluminum and Zinc Die Castings.

MONARCH IS MOBILIZED To Serve You Now!

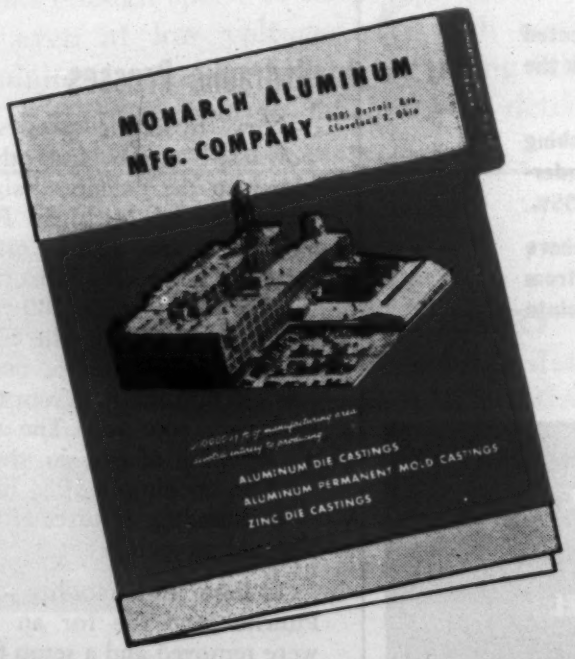
Monarch has already been selected for prime and sub-contract defense requirements. We have capacity for additional production of aluminum permanent mold, aluminum and zinc die castings, plus facilities for complete assembly work regardless of casting requirements.

Monarch-Men work at every useful level in industry. They are in an excellent position to help you solve your own casting and related production problems.

Monarch, under one management for 37 years, has demonstrated the engineering, technical and production capabilities to meet any specific emergency.

Monarch welcomes the opportunity to work with you today in giving the widest possible casting or assembly services, utilizing the full scope of Monarch's unique facilities.

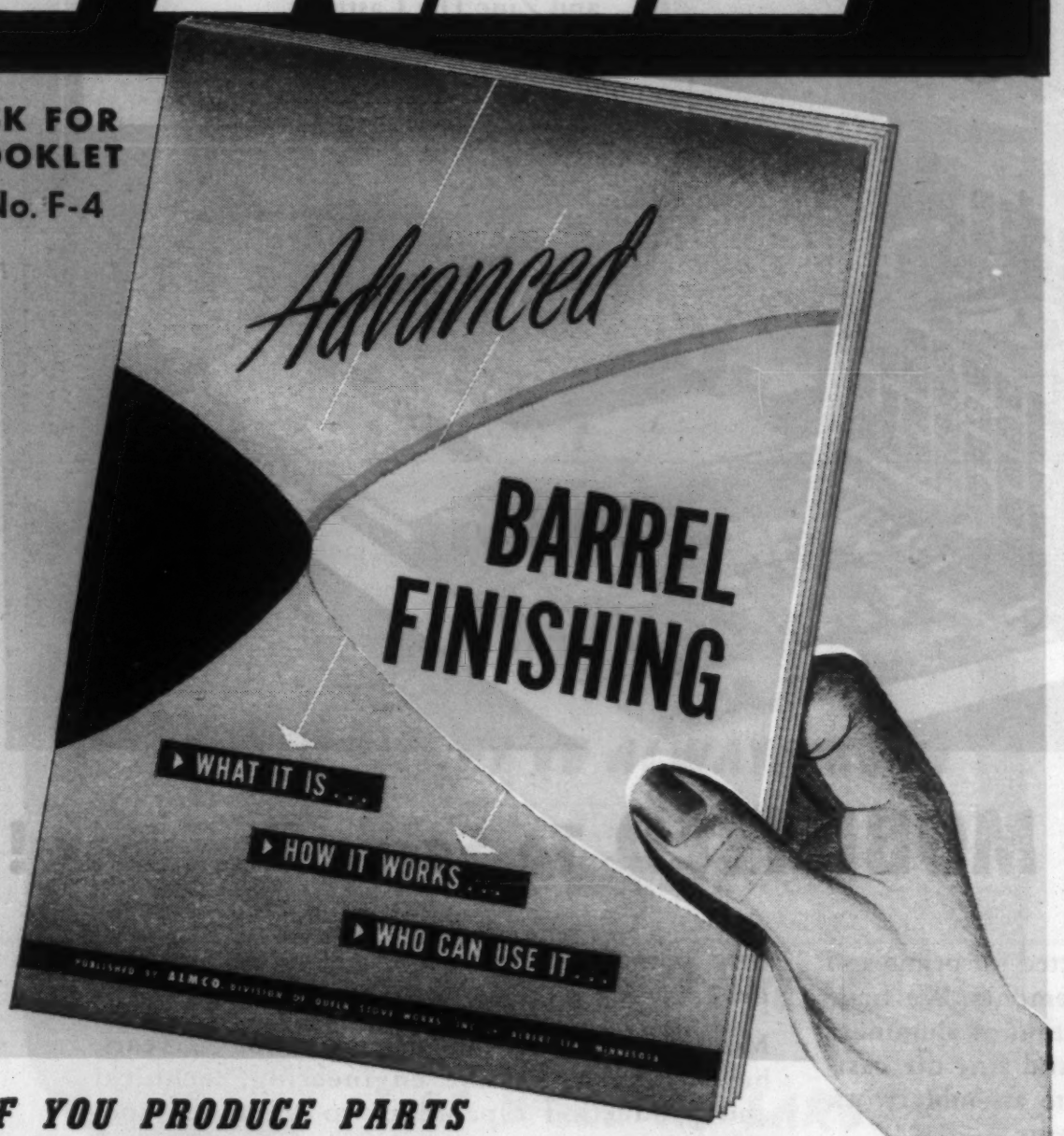
WRITE TODAY *for your copy of our new "FACT-FILE" folder which illustrates and describes Monarch's outstanding facilities. You'll want it for your castings source file.*



MONARCH ALUMINUM MFG. COMPANY • *Detroit Avenue at W. 93rd Street* • *Cleveland 2, Ohio*

FREE

ASK FOR BOOKLET No. F-4



IF YOU PRODUCE PARTS THAT REQUIRE FINISHING OF ANY KIND

This 22-page booklet is guaranteed to open your eyes! It gives you the inside story of advanced barrel finishing as never told before!

In the last five years, barrel finishing has made rapid advances. Only those directly connected have been able to keep up. Only 30% of the nation's manufacturers are benefiting from the tremendous cost savings and improved finishes made possible by these advances.

Now is the time to investigate this labor-saving, cost-cutting method. ALMCO barrel finishing equipment has completely paid for itself in as little as two months! This is easy to understand. A single unit installation replaces from two to twelve men. Savings run as high as 95%.

"Advance Barrel Finishing" is the only mass deburring, grinding and finishing method where results are controlled. Amazing results are now possible on almost all types of parts from large castings to small intricate parts. Close tolerance parts can be finished with absolute uniformity to almost any desired micro-inch reading.

WRITE TODAY FOR YOUR FREE COPY

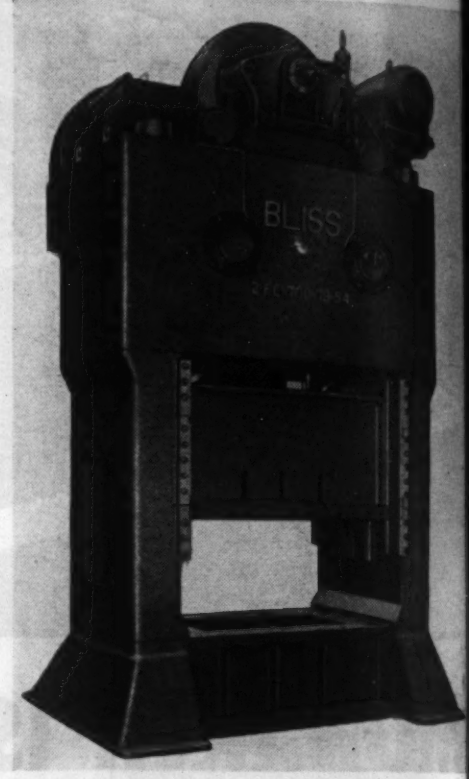
ALMCO Supersheen

AMERICA'S LARGEST MANUFACTURER OF ADVANCED BARREL FINISHING EQUIPMENT — MATERIALS AND COMPOUNDS

ALBERT LEA, MINNESOTA

New Materials and Equipment

lubrication is automatic, consisting of a combination of cascade and pressure types. The drive is double geared with two separate intermediate shafts.



This new 2-FE press is designed for general-purpose blanking, forming and drawing under the most severe operating conditions.

Dimensions and specifications of these units are in accord with standards that were established by the Joint Industry Committee.

Hydraulic Presses

New hydraulic presses designed for powdered metals and other compounds, based on the patents, designs and process techniques of Michigan Powdered Metal Products, are being manufactured by *Arthur Colton Co.*, Detroit.

Nos. 6-125 and 6-100 presses are 4-tie-rod type with 6-in. die fill, one pressing motion from the top, one pressing and one ejection motion from the bottom, and stationary core rod. The die table has a die opening of 8¾ in. through the table with an opening of 10¾ in. for the flange.

Outstanding features of the new presses are said to include:

1. Ease and rapidity of die change. Punches and die for an oil pump gear were removed and a setup for another gear

What's the right X-Ray film?

Product:
Propane Gas Tank
Material:
1/4-inch thick
sheet steel
Purpose:
check bottom weld
Equipment:
120 kv X-ray machine

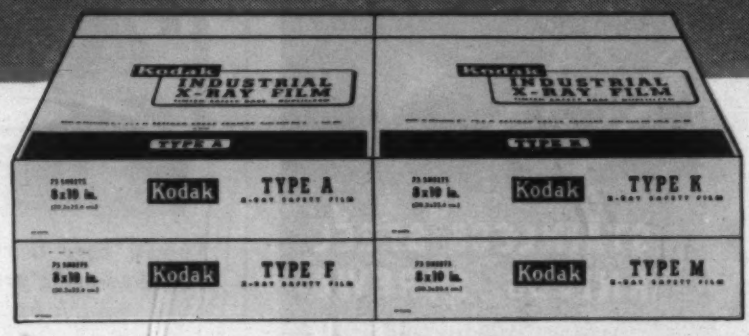
ANSWER:

KODAK INDUSTRIAL X-RAY FILM, TYPE A

With several hundred of these tanks in use, subject to frequent handling as well as high pressure, safety demanded that the bottom weld be sound—that there be no serious lack of fusion or gas porosity.

To make these radiographs, the radiographer used Kodak Industrial X-ray Film, Type A; 120 kv; .005-inch lead screens, front and back.

Type A has enough speed to keep exposures reasonably short even at low voltages. Its high contrast and fine graininess are also valuable in taking full advantage of higher kilovoltage machines in detecting irregularities in thick or dense materials.



A TYPE OF FILM FOR EVERY PROBLEM

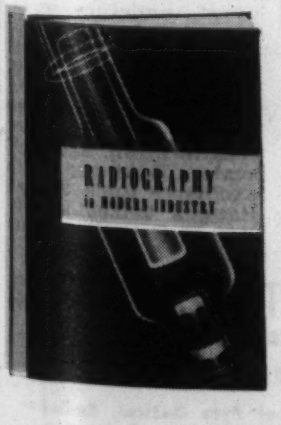
To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. These provide the means to check welds efficiently and thus extend the use of the welding process.

Type A—has high contrast with time-saving speed for study of light alloys at low voltage and for examining heavy parts at 1,000 kv. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, under direct exposure or with lead-foil screens. It has extra-fine grain and, though speed is less than in Type A, it is adequate for light alloys at average kilovoltage and for much million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays, exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get your copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
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Radiography . . .

another important function of photography

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It's been said:

"No one can **BRIGHT-HARDEN STAINLESS** in a conveyor type furnace"

...but we're doing it!

The SARGEANT & WILBUR Controlled Atmosphere **CONVEYOR FURNACE** prevents oxidation, and in many instances produces finished parts *brighter than when they went in!*

STAINLESS STEEL KNIVES, SCREWS and other small parts can now be brought up to maximum Rockwell hardness on a conveyor-belt, production basis, and come out **scale-free, bright** and **clean.** No pickling required, no polishing, no sand blasting — so you not only eliminate those costly operations but your processed parts retain their sharp design, sharp edges.

Your samples processed free. If you want to see some of your own work **bright**-hardened, send us samples and specifications.

SARGEANT & WILBUR, Inc.

180 WEEDEN STREET

PAWTUCKET, R. I.

Send your illustrated folder "How to BRIGHT-HARDEN STAINLESS in the S & W Conveyor Furnace."

Name.....

Company.....

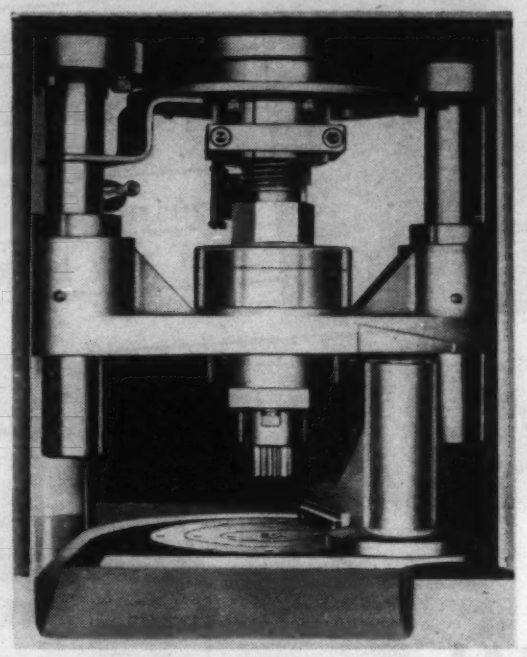
Address.....

New Materials and Equipment

was said to be installed in 1 hr.

2. Compression ratio remains constant.

3. For compacting materials requiring less pressure than metal powders, a shuttle



Shown here is the Colton-Haller No. 6-125 hydraulic press with die table, upper punch holder and feed shoe.

type feed is available, permitting compacting of larger size pieces.

4. Presses are sequence operated; cam actuated switches set the subsequent motions in operation.

Testing & Control

Hydraulic Testing Machines

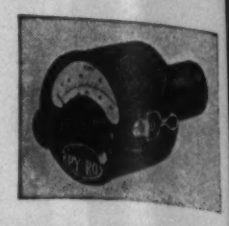
Tinius Olsen Testing Machine Co., 1054 Easton Rd., Willow Grove, Pa., has announced a new line of low cost hydraulic testing machines for simplified, accurate tension, compression, transverse and flexure testing.

Designated the Super L, these machines feature the new Selectorange indicating system with Atcotran unit which is said to make possible a 50 to 1 spread of testing ranges on one 28-in. dial. This indicating system is entirely separate from the loading system in that the load is developed hydraulically and is measured and indicated electronically.

All three test ranges of the unit, full, 1/5 and 1/50 capacities, are indicated in

WHY GUESS THE TEMPERATURE ... When you can SEE it!

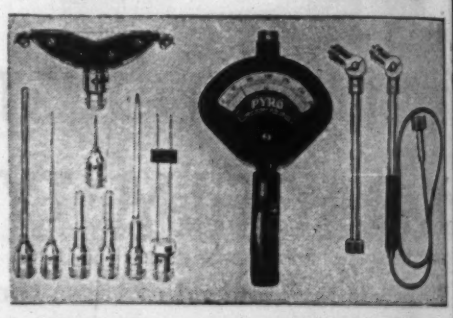
PYRO Radiation Pyrometer



Tells spot temperatures instantly in heat-treating furnaces, kilns forgings and fire boxes. No thermocouples, lead wires or accessories needed! Temperature indicated on direct-reading dial at a press of the button. Any operator can use it. Two double-ranges for all plant needs. Write for FREE Catalog No. 100.

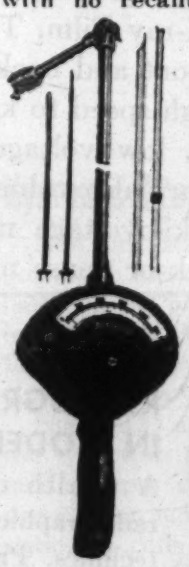
PYRO Optical Pyrometer

Determines temperatures of minute spots, fast-moving objects and smallest streams — at a glance! No correction charts or accessories needed. Easy to use—weighs only 3 lbs. Special types available to show true spout and pouring temps. of molten ferrous metal measured in open. Five temp. ranges. Write for FREE Catalog No. 80.



EIGHT INSTRUMENTS ALL IN ONE

The NEW PYRO Surface Pyrometer handles all surface temperature measuring jobs. Has 8 types of thermocouples; all interchangeable in seconds with no recalibration or adjustment. Automatic cold end compensator, shock, moisture and dust proof. Accurate, big 4¾" indicator, adjustable in 5 temperature ranges. Get FREE Catalogue No. 160.



BETTER TEMPERATURE CONTROL FOR NON-FERROUS FOUNDRIES

The Pyro Immersion Pyrometer is shock proof, moisture proof, dust proof, immune to magnetic influences. Shielded steel housing. Instantly interchangeable thermocouples without adjustment or recalibration. Large 4" scale. Equipped with exclusive Lock Swivel. Ranges 0-1500 and 0-2500 F. Get FREE Catalogue No. 150.

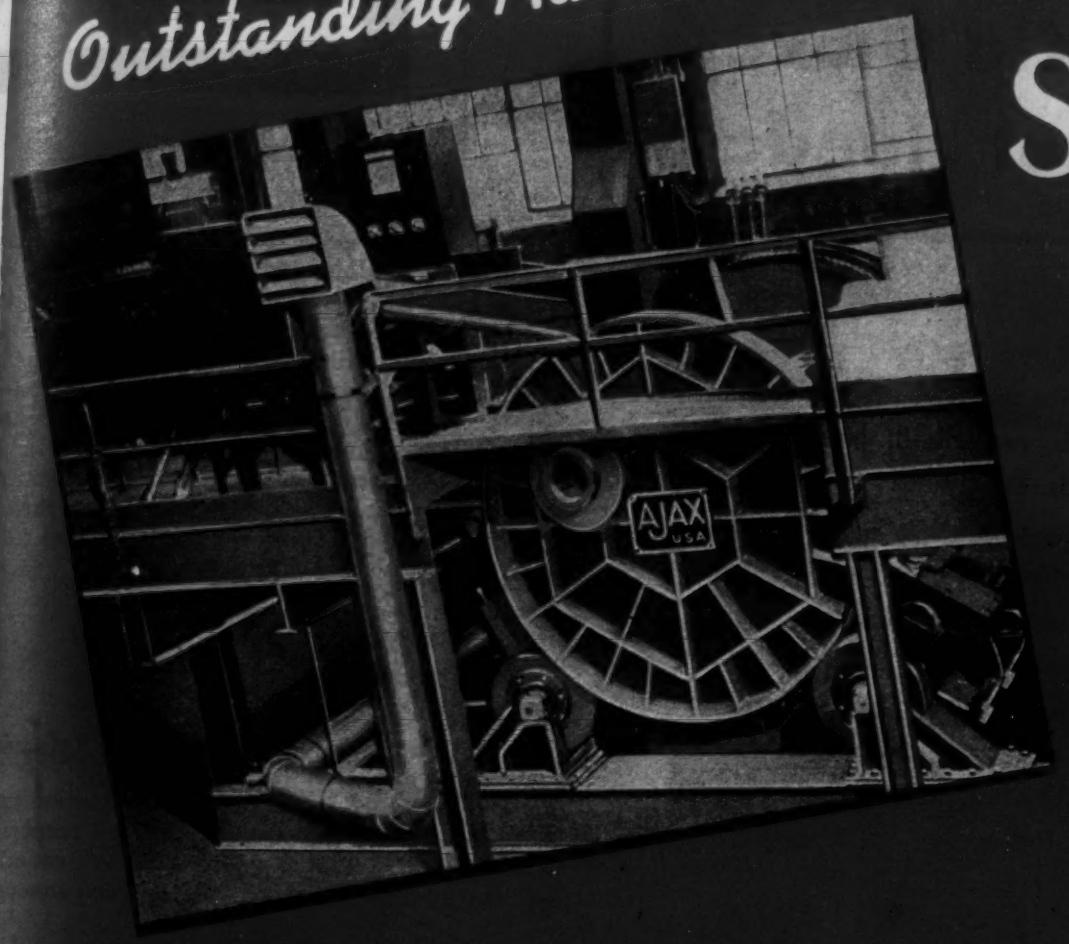
THE PYROMETER INSTRUMENT CO.

New Plant & Laboratory

BERGENFIELD 27, NEW JERSEY

Manufacturers of Pyro Optical, Radiation Immersion and Surface Pyrometers for over 25 years.

TEN *Outstanding Advantages of the* AJAX-SCOMET *High Power* INDUCTION FURNACES *for melting metals*



1. 1000 kW. or more per unit.
2. Uninterrupted around-the-clock production.
3. High efficiency and good operating conditions due to modern design.
4. Adaptable for copper, aluminum, zinc and their alloys.
5. Uniformity of alloy composition insured by large holding capacity.
6. Drastic reduction in labor cost per ton of metal processed.
7. Excellent scrap recovery with controlled metal circulation.
8. Large opening suitable for mechanized automatic charging.
9. Three-phase balanced stable load at line frequency.
10. Decreased lining cost with replaceable "twin coil" inductors.

The photograph shows one of a battery of three Ajax-Scomet furnaces installed at the Scovill Manufacturing Company in Waterbury, Connecticut. Nominal rating 1000 kW., operating up to 1200 kW.

This battery supplies all the metal required by one Junghans-Rossi continuous casting machine for producing 24" wide 2½" thick slabs for rolling. All commercial alloys are produced exclusively in these furnaces, which have been in continuous operation since early 1949.

Our ability to produce furnaces of the capacity shown here is ample evidence that we can fill most requirements, large or small.

Ajax Engineering Corporation, Trenton 7, N. J.

AJAX TAMA-WYATT INDUCTION MELTING FURNACE

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

Kid Gloves Not Needed!

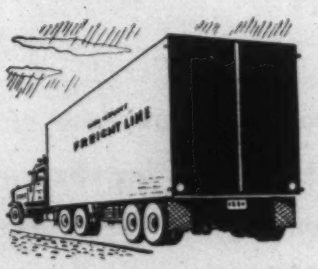
Here's one panel material that needs no "special handling." Reasonable care? Yes. Kid-glove treatment? NO. Douglas fir plywood is *real wood*, cross-laminated for strength. It's tough, durable, split-proof, puncture-proof. Won't crack, chip, break or shatter. Requires only ordinary woodworking tools and techniques. Does a thousand jobs . . . in building and maintenance, in product design and manufacture, in the packaging, shipping and container fields. The coupon brings more information; mail it today.

Put These Advantages To Work For You!

Douglas fir plywood is *real* wood, cross-bonded into panels that are:

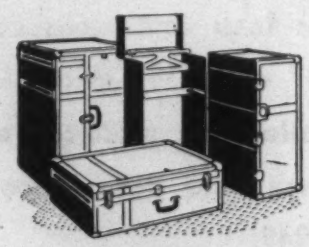
Large, Light, Rigid
Stronger than Steel (pound for pound)
Rugged, Durable
Split-Proof
Puncture-Proof
Crack-Proof
Shatter-Proof
Dimensionally Stable
Versatile*
Easy to Handle
Easy to Saw
Easy to "Jig"
Easy to Nail
Easy to Fasten
Easy to Glue
Easy to Bend
Easy to Finish

*Two types: waterproof-bond EXTERIOR; moisture-resistant INTERIOR. Several appearance grades. Panels 4′x8′ most versatile; smaller and larger sizes, too—including "extra long". Several thicknesses. Produced to rigid requirements of U. S. Commercial Standard CS45-48.



Smooth Plywood Panels Provide Durable Truck Siding, Lining

Big Plywood Panels Are Preferred for Prefabricated Buildings



Plywood Boxes for Luggage Lend Strength, Light Weight

Plywood Pallets are Light-Weight, Rigid, Strong—and Durable

Douglas Fir
Plywood

AMERICA'S BUSIEST BUILDING AND INDUSTRIAL MATERIAL

Douglas Fir Plywood Association
Dept. 464, Tacoma 2, Wash.
Please send me the following:

☐ 1000 Uses for Douglas Fir Plywood
☐ Basic Plywood Catalog

Name.....
Title.....
Firm.....
Address.....
City.....*Zone*....*State*.....

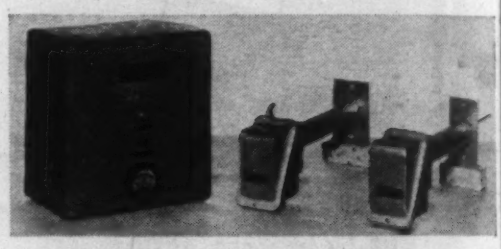
New Materials and Equipment

three different colors on the same dial on the indicator, with zeros for all ranges being identical. Selected load ranges are said to be automatically illuminated as to capacity, value of one division and as to color.

Simply and ruggedly constructed, these low cost machines are provided with hydraulic safety valves and stroke limit switch to prevent overloading and overtravel. By using an Olsen electronic recorder in conjunction with these units, testing ranges can be increased to a ratio of 100 to 1.

Electronic Combustion Safeguard

A new electronic combustion safeguard system for commercial oil burners, which is said to provide immediate cut-off of fuel in case of failure, has been announced by



These components make up the new combustion control system: the master control (left), flame detection phototube (center), and electrode (right).

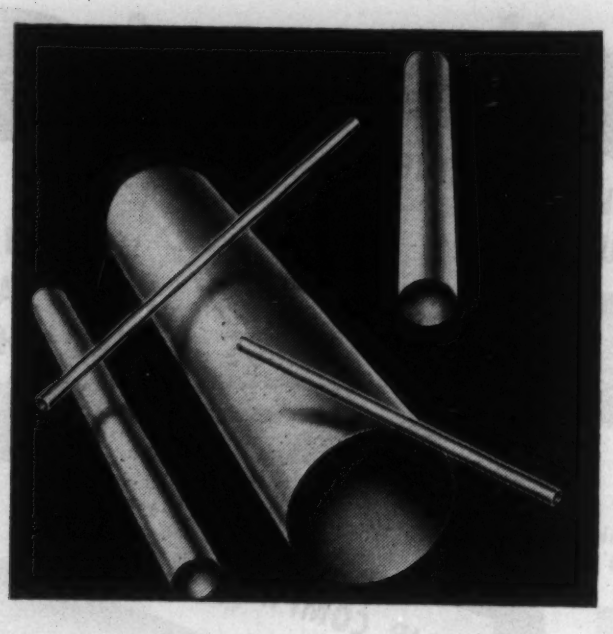
the Control Div. of *General Electric Co.*, Schenectady 5, N. Y.

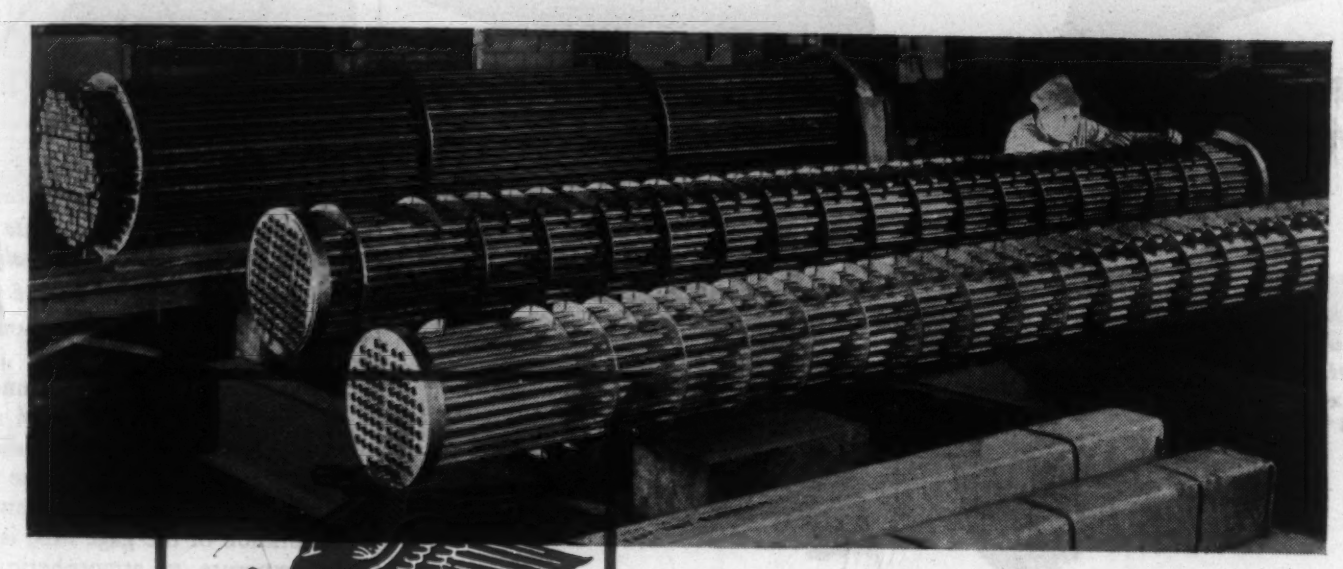
Including a switch-amplifier-contactor unit, phototube holder and electrode holder, the system is claimed to assure positive protection against combustion failure because: if the gas pilot does not ignite, the oil valve cannot open, and if the oil flame does not ignite, the fuel supply is cut off. After the cut-off, the motor continues to operate for 30 sec to purge the nozzle of unburned fuel to prevent carbonizing and reduce field servicing. The system is then locked against further operation until manually reset.

Vacuum Gage

A new vacuum gage with a five-position switching attachment has recently been announced by *Hastings Instrument Co., Inc.*, Hampton, Va.

Said to be capable of measuring absolute pressures of from 0 to 1000 microns of mercury, the new indicator's design in-





A. O. SMITH designs with TRENTWELD

When A. O. Smith, big name in steam and heat transfer equipment recently designed and built a heat exchanger unit for Socony-Vacuum — TRENTWELD Stainless Steel tubing was used throughout. This heat exchanger unit for use in the petroleum industry is another example of how TRENTWELD is preferred by designers for products where stainless steel tubing fits the bill.

And here's why: TRENTWELD is the product of tube specialists. That means you're assured uniform quality and specifications of manufacture that meet your most exacting needs. Then too, TRENTWELD is available in a full range of sizes—⅛" to 36" in diameter, in all grades and finishes. When the job requires stainless steel tubing, check with us. TRENT TUBE COMPANY, *Subsidiary of Crucible Steel Company of America.* General offices and plant — East Troy, Wisconsin; Sales offices in principal cities.

TRENTWELD

STAINLESS STEEL TUBING

Hackney
MILWAUKEE
REFRIGERATION MACHINERY MANUFACTURER
Liquid Freon Receiver 8" x 24"
DEEP DRAWN SHAPES AND SHELLS
AIR COMPRESSOR MAKER
Air Receiver Tank 20" x 60"
FIRE EXTINGUISHER MANUFACTURER
Shell for use in assembly of wheeled chemical fire extinguishers 16" x 51"

CAN YOU USE THE ADVANTAGES HACKNEY SHAPES ASSURED THESE MANUFACTURERS?

These manufacturers are typical of the many who take advantage of Hackney design and production facilities . . . to add to the efficiency and salability of their products. Here are some of the advantages Hackney Deep Drawn Shapes and Shells give them: greater strength, decreased overall weight, improved appearance, elimination of expensive machining operations, faster production and greater durability.

The Hackney Process

This special Hackney method consists of hot or cold cupping from flat circular sheets of metal, cold drawing where it is necessary to obtain desired diameter and wall thickness. Then, to assure the required physical characteristics, the finished product is specially heat treated. Uniform sidewall thickness and a smooth surface finish are assured by careful control of tolerances of the mandrels and dies.

Made to Your Specifications

Hackney Deep Drawn Shapes and Shells are made to your specifications by a company that has specialized in deep drawing for almost 50 years. Send us a sketch of your part and see if this experience can help you improve existing products —or develop new products. *Write us today.*

Hackney MILWAUKEE

PRESSED STEEL TANK COMPANY

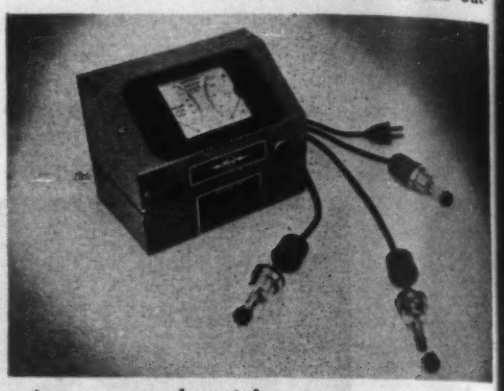
Manufacturer of Hackney Products

1442 South 66th St., Milwaukee 14 • 241 Hanna Bldg., Cleveland 15
1319 Vanderbilt Concourse Bldg., New York 17 • 936 W. Peachtree St., N.W., Room 111, Atlanta 3
208 S. LaSalle St., Room 788, Chicago 4 • 559 Roosevelt Bldg., Los Angeles 14

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

New Materials and Equipment

cludes such features as noble metal thermopiles and nickel-plated pick-up tubes which are claimed to afford freedom from outgassing, system contamination and corrosion.



Accuracy and quick response are said to make this vacuum gage ideally suited for leak detection warning work.

With the switching attachment, as many as five stations per standard selector unit can be connected to each indicator, while matched gage tubes eliminate the need for additional adjustment when switching. The calibration of the gage tube is not affected by exposure to atmospheric pressure or changes in ambient temperature, and there is no need to reset the current each time the pressure changes.

General

Magnetic Conveyor Element

A new type permanent conveyor element, available in three styles for conveying skelp, plate, sheet, rod, bar, pipe and shapes has been developed by *Eriez Manufacturing Co.*, Erie, Pa.

According to the manufacturer, the new type conveyor offers the following advantages:

1. A maximum of conveyed magnetic material is subjected to the direct action of the magnetic field, as the major magnetic field is at right angles to the material movement and extends the full width of the conveyor.
2. Magnetic force is not limited by the diameter of the magnetic rotating member since the magnetic element is a separate unit.
3. Magnetic strength of the unit can be adjusted simply by changing the air gap

When full productive capacity is a *"MUST"*

micarta is basic!

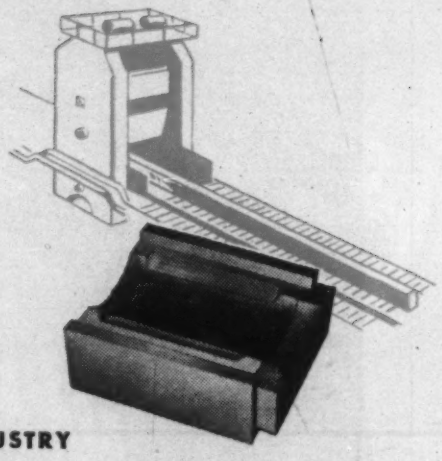
Look to MICARTA® for help in getting and keeping full production. In working longer and better in vital machinery it helps keep things going at top speed. It is a basic material which does many jobs more efficiently than metal.

MICARTA is lighter than aluminum . . . and pound for pound, has a compressive strength greater than structural steel. It cannot rust.

MICARTA resists heat and cold . . . acts as a quencher for noise and vibration. It makes an ideal insulator.

Explore this solid and workable plastic. It can be machined, formed, or fabricated easier and more economically than metal. Westinghouse Electric Corporation, Micarta Div., Trafford, Pa.

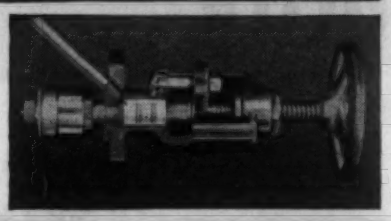
J-06443



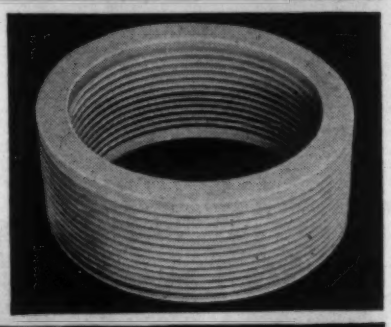
STEEL INDUSTRY

MICARTA toughness improves steel production. It is found in roll-neck bearings, run-out tables, pickling lines, hold-down rolls, punch rolls, and insulators. This workable plastic is solving problems in all industries. Have you got a place for it?

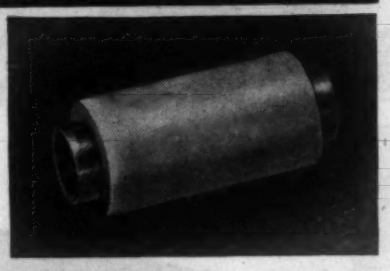
Non-Corroding



Non-Contaminating



Anti-hesive—Tough

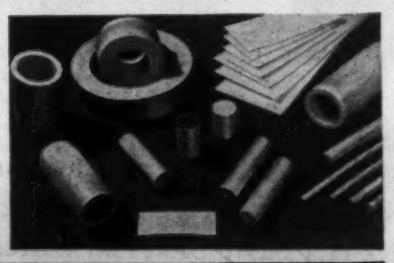


Got a Materials Problem?

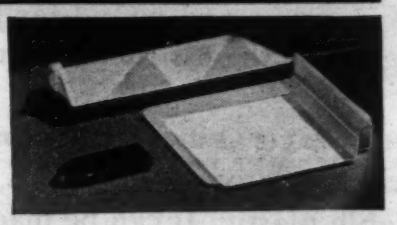
This unique new plastic may solve it and save you money too. For example: a chemical-proof USG Teflon packing, installed in a pump handling hypochlorites, lasted months where all others failed within 5 hours. Or, in the bakery equipment field, USG non-stick Teflon dough rollers eliminate scraper blades and most flour dusting, save bakers $20-$50 a day. Other money-saving Teflon applications include gaskets, expansion joints, scale pans, nozzles, tanks, pump impellers, thermometer wells, heat-sealing platens, and high-frequency electrical insulation.

Chemically inert Teflon can't be attacked by, can't contaminate *any* process material. Teflon is physically tough, extremely anti-hesive, and serviceable from —150° F. to 550° F. Teflon has a low dielectric constant and a low power factor, both constant over the entire range of frequencies measured to date.

TEFLON



Heat-Resistant—Dielectric



More and more materials men are discovering and specifying Teflon, so if the unusual properties of this new plastic sound like a way to improve *your* product and cut manufacturing costs, USG engineers will be glad to help you investigate further. We were one of the pioneers in the Teflon field, and today we are the country's foremost fabricator and supplier of molded and/or machined Teflon parts, Teflon stock, Teflon spray coatings, and Teflon impregnated with glass, carbon, copper or other materials.

Teflon Products Division

UNITED STATES GASKET CO.

656 N. 10th Street • CAMDEN, NEW JERSEY

Typical Properties of "Teflon"

Tensile Strength @ 77 F	1500 to 2500 psi.	Specific Heat	0.25 Btu./lb. deg. F
Elongation @ 77 F	100 to 200%	Heat Distortion Temperature for 66 psi.	270 F
Flexural Strength @ 77 F	Did not break (D790-44T)	Surface Arc-Resistance	Does not track even after 1200 seconds of exposure ASTM D 495-42
Stiffness @ 77 F	60,000 psi.	Volume Resistivity	10^{15} ohm-cm.
Izod Impact Strength @ 70 F 77 F 170 F	2.0 ft.-lb./in. 4.0 ft.-lb./in. 6.0 ft.-lb./in.	Surface Resistivity @ 100% Rel. Hum.	3.6×10^6 megohms
Durometer Hardness	55 to 70	Dielectric Constant, 60 to 10^8 Cycles	2.0-2.05
Compressive Stress @ 0.1% Deformation	1700 psi.	Power Factor, 60 to 10^8 Cycles	0.0005
Deformation under Load @ 122 F, 1200 psi., 85 hr.	4 to 8%	Water Absorption	0.0%
Coefficient of Linear Thermal Expansion from 77 to 140 F	5.5×10^{-5} per deg. F	Flammability	Nonflammable
Thermal Conductivity	1.7 Btu./hr./sq. ft./deg. F/in.	Resistance to Weathering	Excellent
		Specific Gravity	2.1 to 2.3

New Materials and Equipment

between the plate magnet and revolving members suspended above.

4. The power source or magnetic element can be swung down and away from the magnetically induced members, eliminating the magnetic attractive force for easy cleaning, or for nonmagnetic operation.

5. Conveyor elements are easy to repair, resurface or replace. Maintenance cost is, therefore, kept at a minimum.

Labeling Tape

Currently being offered by *Labelon Tape Co.*, 100 Anderson Ave., Rochester 7, N. Y., a new pressure-sensitive labeling tape is said to be water-proof, oil-proof, and acid resistant.

Made of two layers of acetate with a white waxy substance in between, Labelon is claimed to derive its unique writing features from the fact that it is the pressure

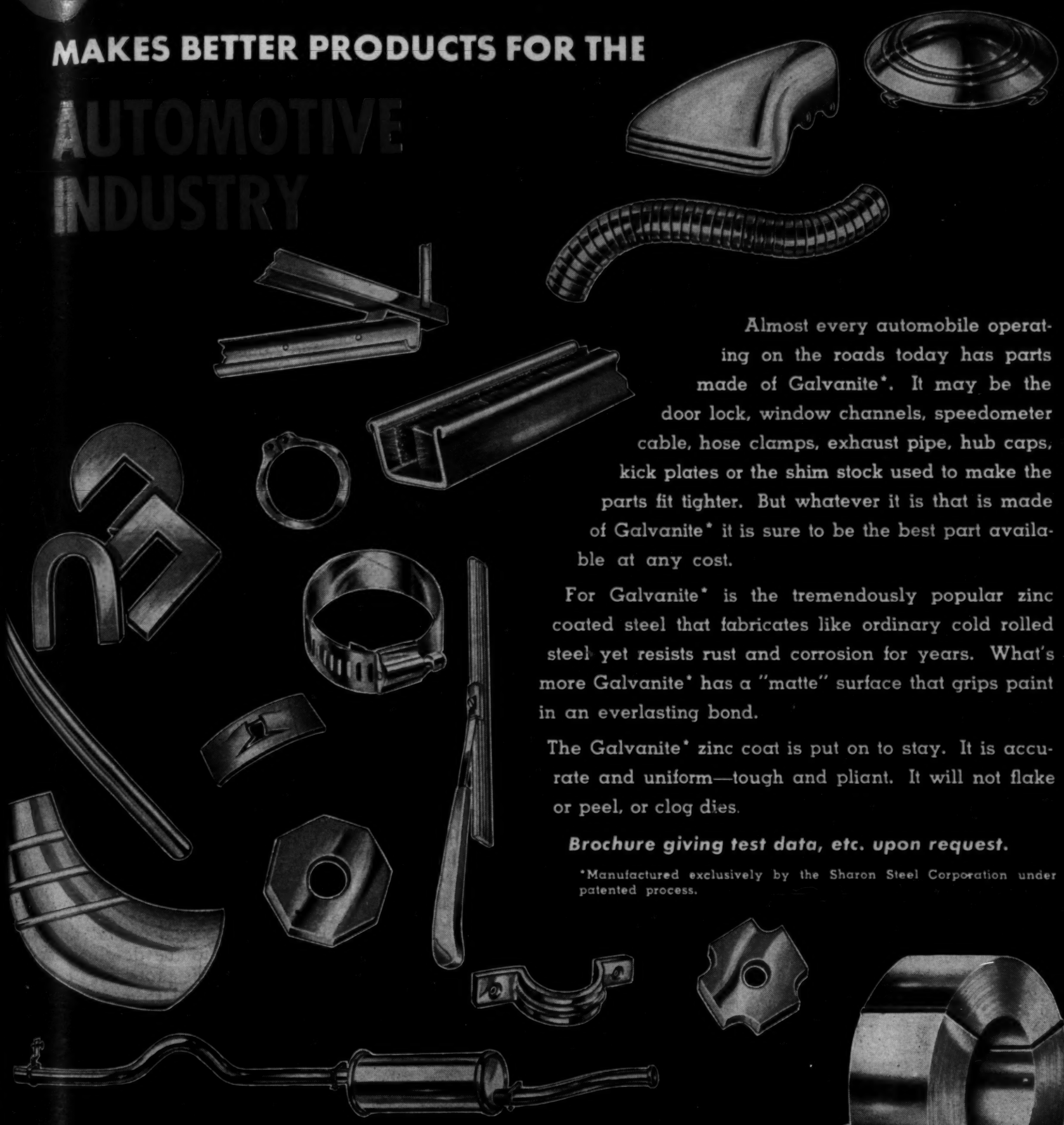
This pressure-sensitive tape requires no moistening and will adhere to almost any surface.

of the instrument used that makes the impression on the tape, rather than the lead.

Available in black, blue, red or green, in ⅜-, ¾-, 1- and 1½-in. widths in 400-in. standard rolls or 800-in. industrial rolls, Labelon is claimed to be ideal for labeling rod and bar stock, shafting, punches and dies, stock bins, jigs, and special parts of all kinds. Since the tape is made from non-hygroscopic acetate, it will not discolor, curl up at the edges or turn yellow with age, and it will adhere and retain its legibility over a temperature range of from —40 to 150 F.

GALVANITE

MAKES BETTER PRODUCTS FOR THE AUTOMOTIVE INDUSTRY



Almost every automobile operating on the roads today has parts made of Galvanite*. It may be the door lock, window channels, speedometer cable, hose clamps, exhaust pipe, hub caps, kick plates or the shim stock used to make the parts fit tighter. But whatever it is that is made of Galvanite* it is sure to be the best part available at any cost.

For Galvanite* is the tremendously popular zinc coated steel that fabricates like ordinary cold rolled steel yet resists rust and corrosion for years. What's more Galvanite* has a "matte" surface that grips paint in an everlasting bond.

The Galvanite* zinc coat is put on to stay. It is accurate and uniform—tough and pliant. It will not flake or peel, or clog dies.

Brochure giving test data, etc. upon request.

*Manufactured exclusively by the Sharon Steel Corporation under patented process.

HARON STEEL CORPORATION

Sharon, Pennsylvania

TS OF SHARON STEEL CORPORATION AND SUBSIDIARIES: THE NILES ROLLING MILL COMPANY, NILES, OHIO; DETROIT TUBE AND STEEL DIVISION, DETROIT, AN; BRADFORD STEEL COMPANY, WARREN, OHIO; SHARONSTEEL PRODUCTS COMPANY, DETROIT, MICHIGAN, AND FARRELL, PENNA.; CARPENTERTOWN COAL CO., MT. PLEASANT, PENNA.; FAIRMONT COKE WORKS, FAIRMONT, W. VA.; MORGANTOWN COKE WORKS, MORGANTOWN, W. VA.; JOANNE COAL Y, RACINE, W. VA. Hot and Cold Rolled Stainless Strip Steel—Alloy Strip Steel—High Carbon Strip Steel—Galvanite Special Coated Products—Cooperage Hoop—Steel Sheets—Hot Rolled Annealed and Deoxidized Sheets—Galvanized Sheets—Enameling Grade Steel—Welded Tubing—Galvanized and Fabricated Steel Strip—Steel Strapping, Tools and Accessories.

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"YOUR PRODUCT WILL ARRIVE IN GOOD CONDITION"—

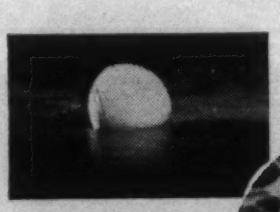
PACKED IN RUBATEX

Labels warn but do not protect. Pack your product in RUBATEX and you provide essential cushioning which assures "arrival in good condition".

RUBATEX is a closed cellular rubber composed of hundreds of thousands of individually sealed balloon-like chambers in every square inch. Each chamber retains inert nitrogen under pressure and is completely surrounded by a membrane of live rubber. This structure forms a dense resilient cushion which literally smothers impact.

RUBATEX cannot absorb moisture. It has high insulating value—is resistant to oxidation and is rot and vermin proof. It has good compressive strength and is extremely light in weight—only 4½ pounds per cubic foot.

The amazing cushioning and shock-absorbing qualities of RUBATEX closed cellular rubber recommends it as a packing material to better protect your product *all the way*. Most package applications can economically be cut from sheet stock. For further information, write for Catalog RBS-12-49, Great American Industries, Inc., RUBATEX DIVISION, BEDFORD, VIRGINIA.



Dropped from a height of more than one hundred feet, this egg bounced off a three-inch-thick pad of RUBATEX closed cellular rubber without breaking. RUBATEX absorbed and dissipated the impact shock equal to a velocity of more than sixty miles an hour.

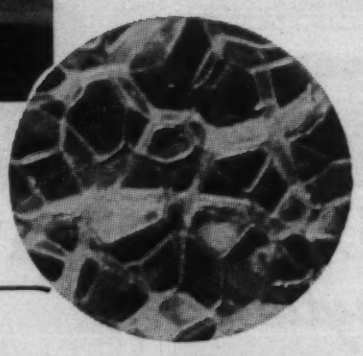


Photo-micrograph of RUBATEX closed cellular rubber shows the tiny individually sealed balloon-like chambers which retain inert nitrogen under pressure.

RUBATEX®

CLOSED CELL RUBBER

FOR GASKETING • CUSHIONING • SHOCK ABSORBING • VIBRATION DAMPING

News Digest

Prior Stress Effects

(Continued from page 11)

this portion was approximately equal to the ratio of the number of cycles run at a given prestress to the number of cycles which will cause failure at that stress.

For the lowest prestress (17,000 psi) however, the behavior was entirely different. At a slightly higher test stress (20,000 lb), there was a noticeable improvement in the life of the specimens. Two thousand cycles and 2,000,000 cycles of prestress produced an increase of more than 400%. Even at 20,000,000 cycles, the increase was of the order of 33%.

Porcelain-Enamel Research Undertaken at Battelle

Seventeen companies, representing a major segment of the country's manufacturers of porcelain-enameled steel products, cooperatively have undertaken a research program at Battelle Memorial Institute, Columbus, Ohio, to establish the fundamental mechanics of adherence of ceramic coatings to steel.

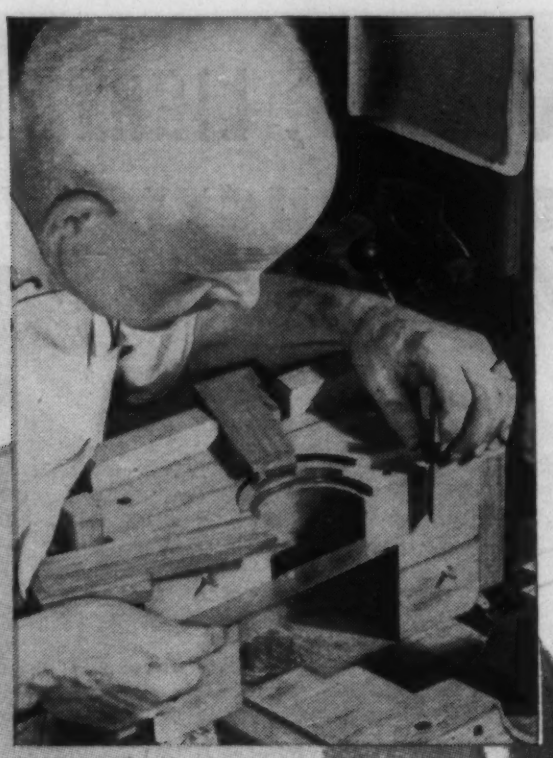
The problem, according to Batelle Director Clyde Williams, is to provide a scientific basis to pave the way for improved porcelain enamels for such products as refrigerators, ranges, kitchen cabinets, stoves, and other enameled products. Another objective is to provide fundamental information leading to the development of decorative and protective ceramic coatings prepared from nonstrategic materials.

According to Dr. Williams, the work is specifically directed toward:

(1) Determining and evaluating the factors which contribute to adherence.

(2) Determining the fundamental physical and chemical basis of adherence.

Particular attention is being given to the functions of cobalt, manganese, nickel and other metallic oxides in promoting adherence, and to the subjects of "wettability," constant angle, and stability of enamels. It is believed that from the research the industry



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MEANS BETTER CASTINGS FOR BETTER PRODUCTS!

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When you order castings from the Eclipse-Pioneer Division Foundries, you *know* they will be right. Your confidence is justified at *every step* in their manufacture, from first planning to final check, for each man is an expert in his field and each operation is backed by more than twenty years experience. But, this craftsmanship is only part of the picture. As a further guarantee of quality, the Eclipse-Pioneer Foundries use the most modern machines, techniques and testing devices obtainable . . . the entire production line is conveyorized to assure rapid and economical service on all orders. Take advantage of these extras. If you plan to use aluminum and magnesium castings, make it a point to consult Eclipse-Pioneer. Meanwhile, send for Eclipse-Pioneer's "Book of Facts".

ALL
Aluminum and Magnesium Alloys
Including the recently developed
Cerium and Zirconium Magnesium Alloys

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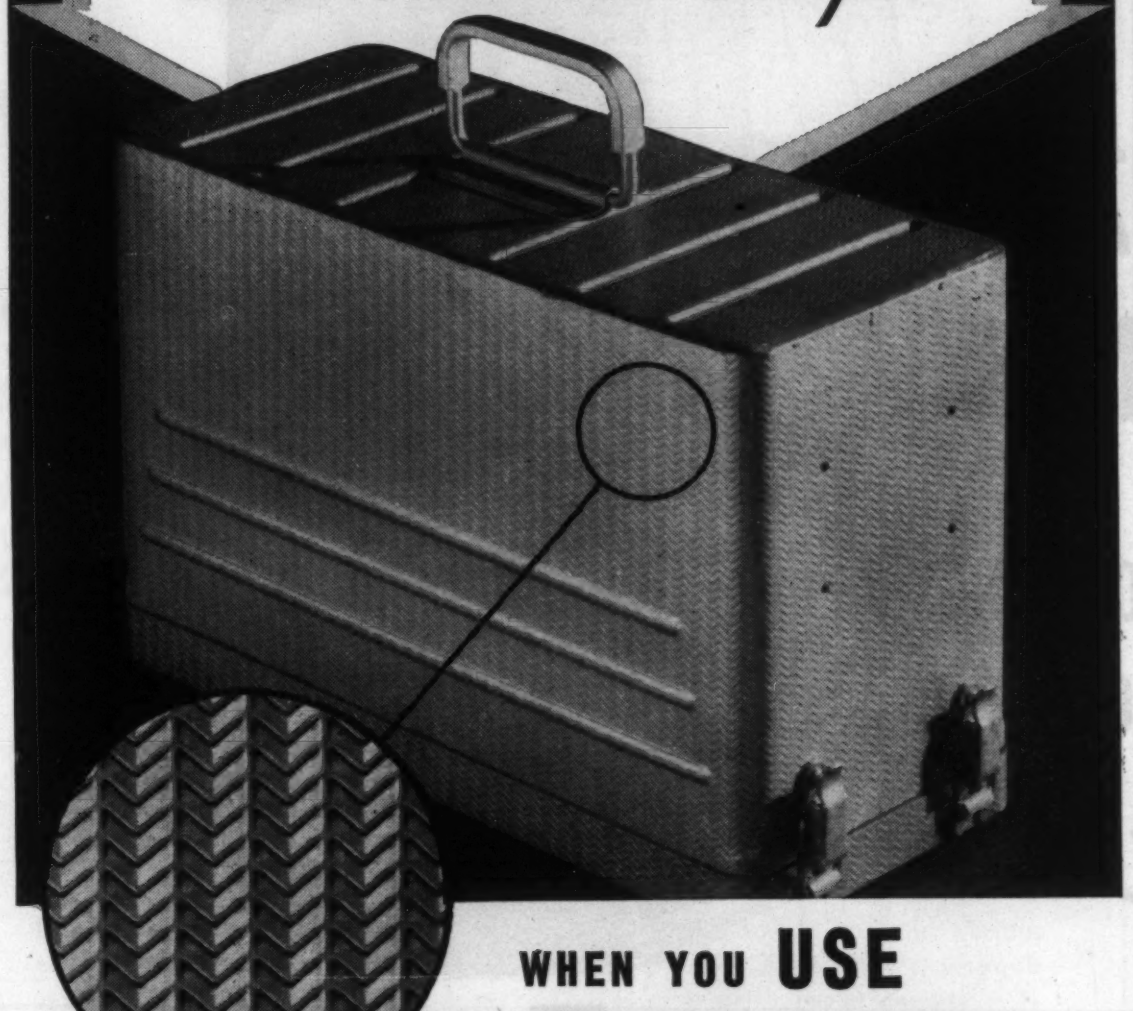

Full Size Rigidized Metals Pattern 2-H.B.

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Rigidized DESIGN STRENGTHENED Metals

Lightweight electronic equipment carrying cases of RIGIDIZED Design-Strengthened Metals give you mar-resistant surfaces that minimize dents, scratches, water marks and fingerprints . . . Keep their new look.

The durable versatility of RIGIDIZED Metals can be applied to limitless other products where it is advantageous to combine lightweight with high-strength ruggedness. Freight shipping boxes, X-ray unit boxes and food containers for aircraft galleys are only a few applications where RIGIDIZED Metals construction withstands shock and protects valuable contents during constant handling.

There is a RIGIDIZED Metal pattern for nearly every purpose in the entire manufacturing field. If you wish surface protection, metal conservation with maximum strength-weight ratios, and gauge thickness reduction, it will pay you to investigate the vast possibilities offered you by RIGIDIZED METALS.

Send for your copy of the *Rigidized Metals IDEA Handbook* TODAY

Rigidized Metals Corporation

660 OHIO STREET, BUFFALO, N. Y.

News Digest

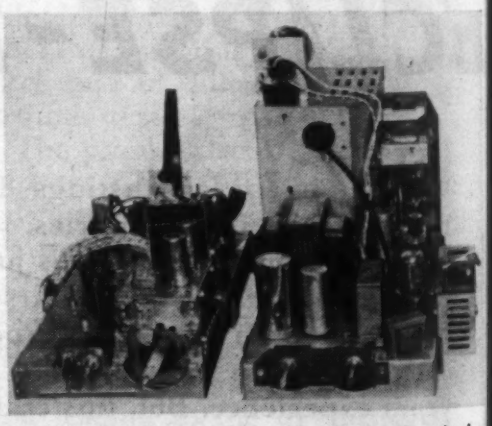
will be in a strengthened position to develop new and improved ceramic coatings and base metals for conventional and special applications, new treatments for base metal, and improved shop control resulting in fewer rejects or re-runs.

The laboratory investigations at Battelle are under the supervision of Dr. C. H. Harman, and are being coordinated by L. S. O'Bannon. Cooperating scientists include Dr. B. W. King, H. F. Reid, H. E. Elsea, F. L. Shubert and G. K. Manning.

TV Chassis Conserves Strategic Materials

A two-year engineering development program of the Philadelphia Corp. has resulted in the design of a new television receiver chassis which combines performance superior to previous models with conservation of strategic materials.

Design changes incorporated in the new chassis have replaced critical materials wherever possible. The use of cobalt has been eliminated entirely, and the amount of aluminum has been cut by 68, silicon steel by 58, copper by 26 and nickel by 15%. Tin will be conserved in considerable quantity in producing the new Philco chassis by using a new solder with 20% tin content, instead of the present solder with 40% tin; and by using



New Philco television receiver chassis has been proved superior to present designs in extensive field tests, and also conserves many critically scarce materials. Total weight saved by the new Philco television chassis and picture tube assembly is 12.12 lb, or about 30%. The percentage saving in critical materials is much higher.

HOW TO CALL AN END TO PHENOLIC MOLDING PROBLEMS

Call on Borden's DURITE.

The handset above is a good example of special properties in DURITE phenolic molding compounds created by Borden engineers to meet customers' special requirements. And a tough order it was . . . meet rigid government specifications for high impact strength, yet maintain sufficient resilience to withstand flexural loads.

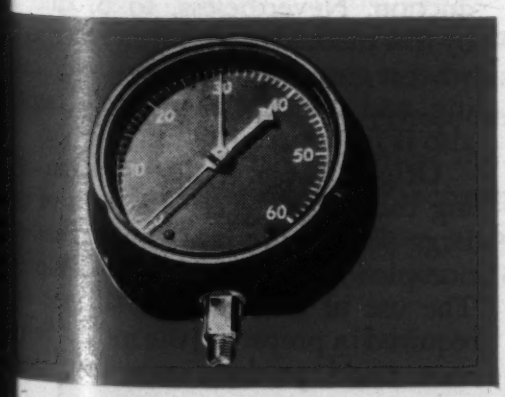
This product molded of DURITE withstands sanding and buffing, resists body acids without dulling.

For applications of this nature, both military and civilian, specify Borden's DURITE GP-120, Black.

In DURITE, Borden gives you the special properties you need, in the degree you want, by skillful combining of cellulosic, carbonaceous and mineral fillers with the resin base. Address your molding problems requiring Phenolic Molding Compounds to The Borden Company, Chemical Division, Dept. **MM-41,** 350 Madison Ave., New York 17, N. Y.

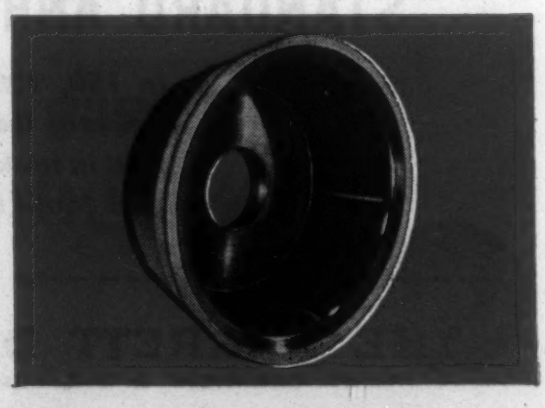
Borden's DURITE

Molding Powders • Bonding Resins • Cements



Lustrous finish, high impact, dimensional stability are special properties of the Borden's DURITE phenolic used in this instrument housing.

Highest impact, good finish, uniform density are special properties of the Borden's DURITE phenolic used in this good-looking gun grip.



Improved impact coupled with good heat resistance are special properties of the Borden's DURITE phenolic used in this diamond wheel core.

to help speed your production

Barrett Standard Anhydrous Ammonia has many applications in metal treating. When you need ammonia, it will pay you to place your order with Barrett—America's leading distributor of Ammonia—with more than 50 years of experience in this basic chemical.

Fast delivery is a special feature of Barrett service. Convenient coast-to-coast stock points make it easy. When you buy Barrett Standard Anhydrous Ammonia, you know you can depend on speedy arrival of ammonia of unexcelled purity and consistent high quality.

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News Digest

a new flux with this solder to make permanent soldered joints. The resultant saving amounts to 80,260 lb of tin, a strategic material, per million television receivers.

Zinc is being conserved by means of eliminating some zinc die castings; by the saving of ferrite; and also by eliminating brass wherever possible. All brass hardware and machine screw parts are being replaced with steel, wherever ferrous metals can be employed. The amount of brass in control bushings has been reduced about 10%. All brass formerly used for decorative purposes on the cabinet is also being removed.

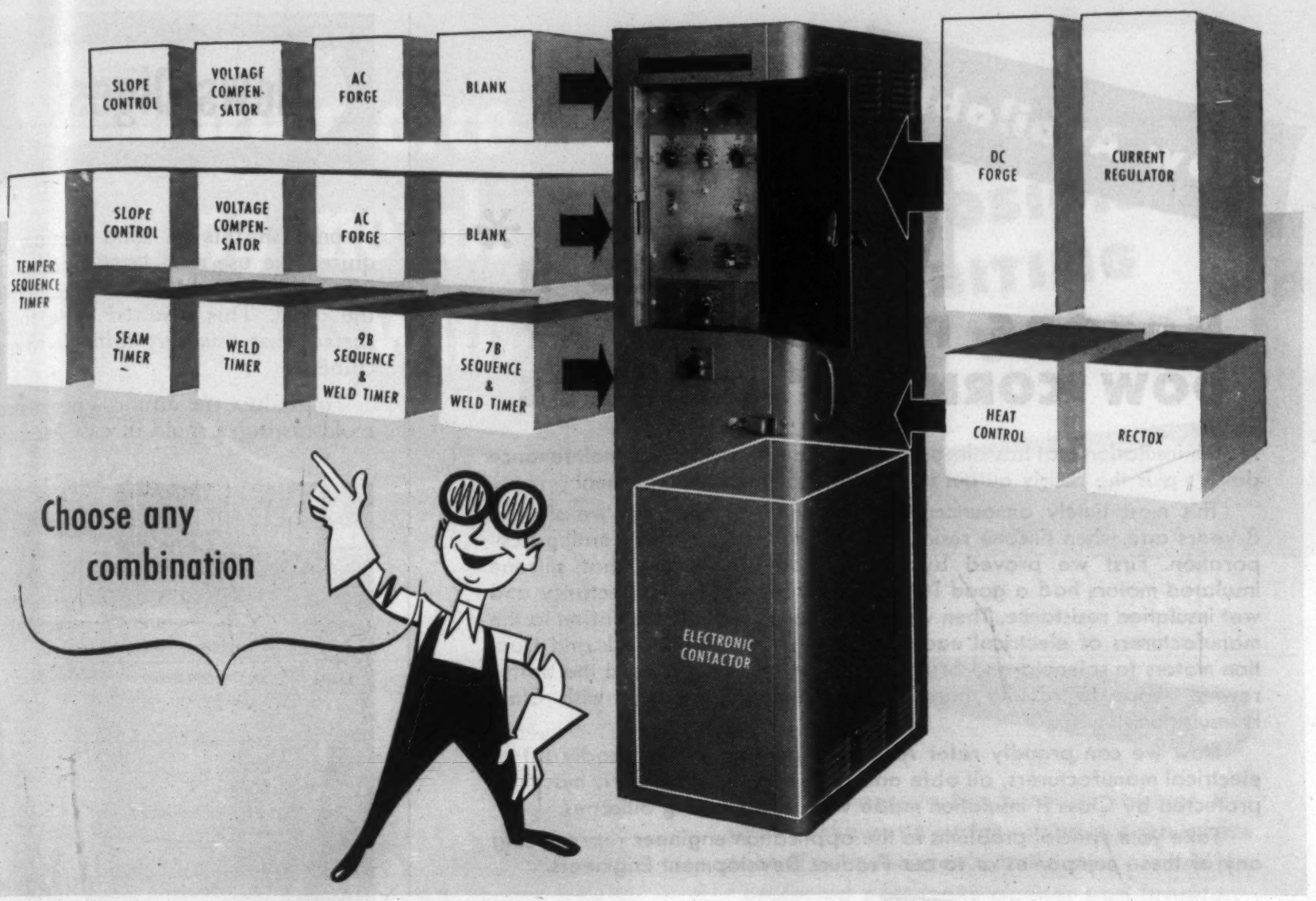
The new design saves a total of 12 lb, 2 oz per receiver. This weight saving means not only a substantial conservation of critically scarce materials; it also means that new, lighter chassis will be easier to handle in production, thus reducing the fatigue of workers. Further, the lighter chassis will appeal to future owners of the new sets, especially table models which are often moved from room to room, or from one location to another in a room.

Largest Permanent-Mold Aluminum Casting

A new milestone in the aluminum casting art has been established at the John Harsch Bronze and Foundry Co. Cleveland, Ohio, with the successful production of a permanent-mold casting weighing 500 lb. The total production run on this unit is much smaller than that normally considered minimum for permanent-mold production. Nevertheless, to produce it by this method costs only a fraction of what it cost to produce as a sand casting, and the permanent-mold casting also is far superior.

Originally, the company began casting the part in sand. Because of the large size of the unit, this operation occupied four bays in the foundry. The use of a large sand slinger was required in preparing the molds. Seven men could produce only four units a day.

To develop the required strength in the cast metal, the entire inner surface of the unit must be chilled. T



KEEP YOUR WELDING CONTROLS OUT OF MOTH BALLS

Interchange these components to match production changes

Now you can keep your resistance welding control "on the line", regardless of production changes. With a Westinghouse Welding Control you merely add or substitute the necessary control components.

The Westinghouse Welding Control is built up of basic control components and auxiliary control units. Basic controls include the electronic contactor and sequence and weld timer, synchronous or nonsynchronous. Auxiliary controls include a wide range of functional units among which are: forge timer, slope control, voltage compensator and dual weld attachment. Combinations of the complete line of components can be assembled to meet the needs of practically all resistance welding techniques. All component units plug in to either a 600 or 1200-frame electronic contactor structure.

Each unit is self-contained and completely prewired at the factory. Mount the panel and insert the polarized plug—that's all it takes to make a complete change-over.

Many other advancements in control design such as the transformer-type flow switch, are built into this packaged control for resistance welding. Get the complete story from your Westinghouse representative or write for Booklet B-4309. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-27006

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RESISTANCE WELDING CONTROL

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NEW CLASS H* MOTORS PROTECTED BY DOW CORNING SILICONES

. . . the insulation that has already saved industry millions of maintenance dollars plus the hourly output of hundreds of thousands of men!

This most timely announcement caps the test program we started 8 years ago when silicone resins were introduced by Dow Corning Corporation. First we proved by accelerated life testing that silicone insulated motors had a good 10 to 1 advantage in life expectancy and wet insulation resistance. Then we sold silicone (Class H) insulation to the manufacturers of electrical equipment ranging from lift truck and traction motors to solenoid and brake coils. We also encouraged the better rewind shops to rebuild hard working industrial motors with Class H insulation.

Now we can proudly refer American industry to this goodly list of electrical manufacturers, all able and willing to supply electric machines protected by Class H insulation made with Dow Corning Silicones.

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* "Class H" insulation is the kind of insulation that keeps motors running in spite of "Hell and High water." *(slanguage dictionary)*

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accomplish this in sand casting required the use of a large number of iron chills placed close together in the mold. This resulted in a rough surface that was very difficult to machine.

To produce the unit as a permanent mold casting, a mold of cast Meehanite weighing nearly ten tons was constructed. The mold is 65 in. high and has an average diameter of about 46 in. It is constructed of hinged sections which ride on rollers to facilitate opening and closing. Rows of gas burners surrounding the mold maintain it at uniform temperature for optimum pouring conditions.

A 500-lb. permanent mold aluminum casting is now being produced.

Not only does the permanent-mold method produce castings of higher strength than the sand castings, but also the smooth surfaces are much easier to machine. Only one bay in the foundry is required for the permanent-mold operation, and four men can produce 12 units a day.

See Page 13 for the Metal Powder Show Preview

Replace scarce plating metals with

JOHNSON'S CORROSION INHIBITING METAL WAXES

Hard dry protective finishes for

BRASS
COPPER
ALUMINUM
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PHOSPHATED STEEL
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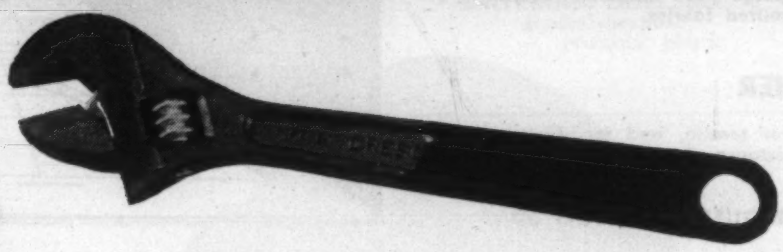
ALL METAL SURFACES

Easily applied by dip, spray, wipe, flow, roller coat



After 128 hours in the humidity cabinet, this wrench shows no surface deterioration where coated with Johnson's Metal Wax . . . and the protected part looks cleaner and brighter.

Shortages of electroplating metals as well as finishes, lacquers and enamels are bound to become an ever-increasing problem. And the answer is—Johnson's Corrosion Inhibiting Metal Waxes!

They offer excellent protection for black oxidized, phosphated, Bonderized, Parkerized, painted or untreated metal surfaces . . . because they provide an unbroken film that keeps out moisture. Available in clear or black, they dry to a hard, tack-free, lustrous finish that is uniform, durable and flexible.

MAIL THIS COUPON!

Look into the many merits of Johnson's Corrosion Inhibiting Metal Waxes now! Write for facts concerning your particular needs.

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Industrial Products Department
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Industrial Products, Dept. MM4
S. C. Johnson & Son, Inc.
Racine, Wisconsin

☐ Enclosed is a brief description of my metal protection problem. Please send me a sample of your Metal Wax for a test plus application information. I understand that this does not obligate me in any way.

☐ Please arrange for a Johnson representative to call.

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News Digest

Bearing Strengths of Aluminum Castings

Due to the interest of aircraft manufacturers in the bearing properties of permanent-mold aluminum casting alloys, an investigation was made by the Aluminum Co. of America. The results have been made available to the National Advisory Committee for Aeronautics because of its general interest.

Bearing tests were made to determine bearing ultimate and yield strengths of aluminum-alloy permanent-mold castings of B195-T4, B195-T6 and 356-T6, and to compare the ratios of bearing to tensile properties obtained with similar data from sand-castings of like material. It was found that the bearing strengths of the permanent-mold aluminum-alloy castings were not significantly different from those which have been observed for sand-castings, and that the ratios of bearing strengths to tensile strengths of the permanent-mold castings were slightly less than those previously observed for sand-castings.

As a basis for selection of allowable bearing values for the design of B195-T4, B195-T6 and 356-T6 aluminum-alloy permanent-mold castings, the following ratios are proposed: (1) Ratio of bearing ultimate strength to tensile ultimate strength, 1.4 for edge distances of 1.5 times pin diameter and 1.8 for edge distances of 2 times pin diameter; and (2) ratio of bearing yield strength to tensile yield strength, 1.6 for edge distances of 1.5 times pin diameter and 1.8 for edge distances of 2 times pin diameter.

Neolite Gets Out from Under

Neolite, a development of the Goodyear Tire & Rubber Co. previously produced as a sole, heel and innersole material for the shoe trade, will soon be manufactured on a mass production basis for the luggage, handbag and accessories industries.

Product of a vast research and experimentation program, Neolite, born in a test tube, is not a substitute for leather. It is a man-made material,

It pays to use your custom molder's know-how

and proof is clear on a million TV screens

No. 26 in a Series on Plastics Skill at Work...

PROJECT: Deflecting yoke spool for TV picture tubes

CUSTOMER: RCA Victor Division, Radio Corporation of America

MOLDER: Shaw Insulator Co.

MATERIAL: Durez black general-purpose phenolic plastic

ONE RIM OF SPOOL serves as terminal board for 8 terminals, and supports small resistors and capacitors. Molded-in interlocking projections facilitate assembly of the 2-piece spools. The use of molded half-spools made it possible to replace approximately eight parts formerly used.

EIGHT HALF-SPOOLS of Durez phenolic per "shot" are produced by custom molder. These meet rigid requirements including very thin walls, dimensional exactness, freedom from warping, high insulating value, and resistance to heat.

"Riding" the neck of the modern cathode-ray TV picture tube is a deflecting yoke . . . deflecting coils and magnetic core . . . which guides the electron stream that is transformed into glowing video pictures on the screen face of the tube.

The yoke is the extremely critical component that determines the uniform brightness of the picture, its symmetry, and freedom from exaggeration and distortion. Its elements must be supported in an exact relationship, and insulated to withstand high voltage.

This is the job of the spool molded of Durez phenolic plastic . . . another example of the custom molder's know-how in meeting severe requirements with parts that simplify assembly. Supplanting a stapled cardboard assembly, the molded Durez spools have contributed to the dramatic growth of the television industry by making possible a distinct improvement in a vital component in more than a million sets.

Your custom molder's know-how, plus the famous versatility of Durez phenolics, is a hard-to-beat team when you want the best value you can get for your plastics dollar.

Ready with skilled counsel is your Durez technician, backed by over 25 years of specialized experience.

Our monthly "Durez Plastics News" will keep you abreast of industry's uses of Durez. Write, on office letterhead, to Durez Plastics & Chemicals, Inc., 1404 Walck Road, North Tonawanda, N. Y.

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PHENOLIC RESINS

- MOLDING COMPOUNDS
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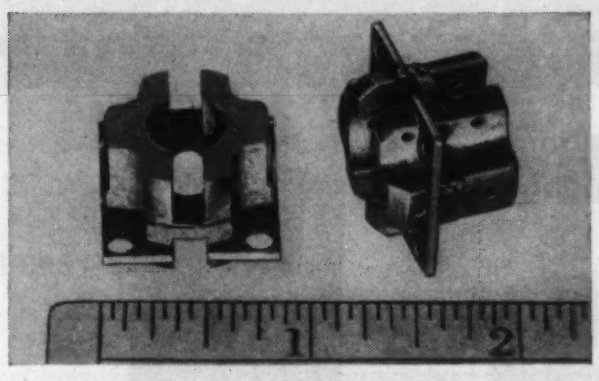
PHENOLIC PLASTICS THAT FIT THE JOB

A Manufacturing NIGHTMARE?



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IF YOUR MANUFACTURING PROBLEM ENTAILS—

1—Multiple machining operations.
2—Expensive tooling for short run production.
3—Complex coring and complex shapes.
4—Individual components to be combined in a single cast assembly.

THEN SEND US YOUR BLUEPRINTS so our engineers can tell you how we can solve your problem at low cost.

Literature on request.

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- Smooth surfaces and dimensional accuracy reduce finishing time.

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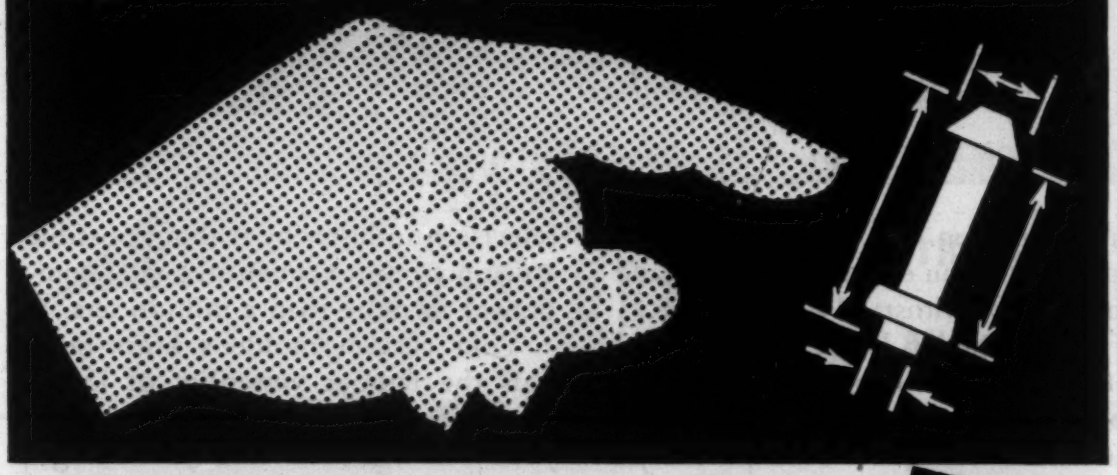
specially engineered fasteners



Hassall cold-headed fasteners can improve your products and save you money, even on short runs. Send us your specifications for your nails, rivets and screws . . . in diameters from 1/32" to 3/8" . . . lengths up to 7" . . . in any workable metal . . . in practically any finish. Your inquiry will be handled promptly. Ask for free catalog.

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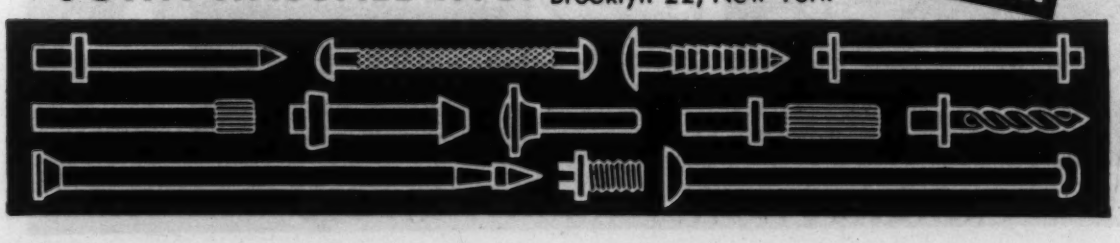

News Digest

neither rubber nor plastic, which possesses properties of leather, plus distinctive characteristics of its own. It can be made to look like leather. It has the flexibility of leather. But there the similarity ends.

Neolite is waterproof because it is nonporous. It is colored by an adhesion process similar to that used in coloring metal, can be manufactured in standard qualities. In other words, every piece of Neolite of specified gage and width is exactly like every other piece of the material of similar thickness and size. In addition to being waterproof and uniform, the new material resists wear better than leather and will not crack or dry out.

Two New Elements Confirmed

Recent spectroscopic investigations by W. F. Meggers, B. F. Scribner and W. R. Bozman, of the National Bureau of Standards, give positive identification of two new artificial elements. Not found in nature, the elements—known as technetium (Tc) and promethium (Pm)—are by-products of uranium fission. They were supplied by the Atomic Energy Commission. Studies at the Bureau of the first optical spectra of these elements have revealed by analysis and interpretation many properties of the atoms and of their nuclei. They have also provided reliable wavelengths and intensity data for about 5000 new spectral lines, the strongest of which are at least one thousand times more sensitive than their x-ray spectra.

For many years these two predicted chemical elements were vainly sought in nature. One was predicted in 1869 by Mendeleev, whose observation that chemical valencies were periodic functions of atomic weight led him to affirm that a chemical homolog of manganese was unknown. The other was predicted in 1902 by Brauner, who pointed out that the atomic weights of neodymium and samarium differed by six units, whereas the average difference in weight of proximate rare earths was only three units.

In 1913 the discovery by Moseley of a simple relation between x-ray frequencies and atomic numbers fixed the atomic numbers of the two elusive

American Offers FELTS TO ARMED FORCES SPECIFICATIONS

If you have Defense Order Contracts, or subcontracts calling for the use of wool felt, get in touch with American. We can supply you with the felt to meet your specifications.

When writing, please use these felt specification numbers on your contracts.

This information is important, since in recent years there have been changes in Federal specifications for wool felts. American knows and will gladly work closely with you to see that Defense Orders for felt are filled with material that meets the requirements exactly.

Note These Two Specifications

Here are the two most important specifications for wool felt.

Specification No.	Title
Air Force Contracts	
MIL-F-5656 (Supersedes AN-F-14a) (Identical with S.A.E. Felt Specifications)	*Felt Wool*
All Other Contracts	
Federal Specification C-F-206 (Identical with S.A.E. Felt Specifications)	*Felt Mechanical Roll*

American Felt Company

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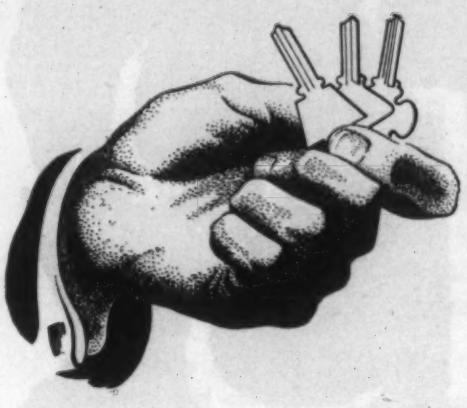
ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

You can have "3 Keys!"



Our book "3 Keys to Satisfaction" is 72 pages of facts and figures of significance to designing engineers. It sets out the vital relationship between good design, good steel and good treatment, and shows how to get a specified service from a part at least cost.

There is a copy for you—it is worth sending for—and free on request.

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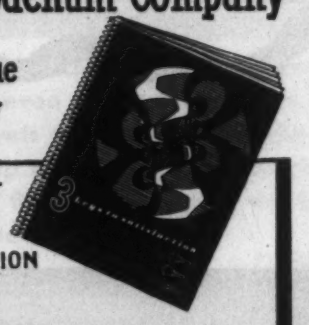

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MOLY

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News Digest

elements as 43 and 61, respectively. In 1925 three German scientists published three x-ray wavelengths as proof that they had concentrated and identified element number 43, which they named masurium. This discovery was never repeated or confirmed. Likewise, in 1926 x-ray evidence for the discovery of element 61 was reported almost simultaneously by two groups of American scientists and by a pair of Italian chemists.

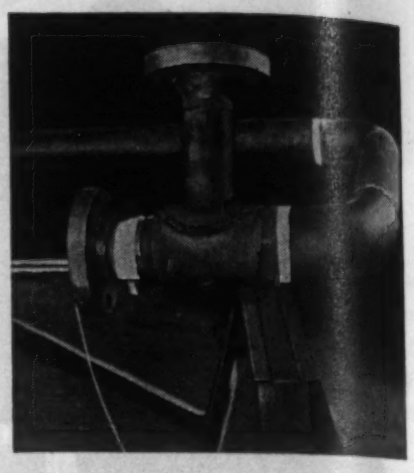
After the discovery of artificial radioactivity in 1934, it became theoretically possible to manufacture these unseen elements by transmutation of others, and because element 43 was indeed first technically produced in 1937 by neutron bombardment of molybdenum 42, it was named technetium. But the transmutation yield, even with the largest cyclotrons, is very small. With the construction and operation of chain-reacting uranium piles in 1942, an entirely new and vastly more efficient method of making the missing elements became available. When uranium undergoes fission, 6.2% of the atomic fragments become atomic number 43, and 2.6% become atomic number 61. The former is called technetium, and the latter has been named promethium.

Continuous Casting of Steel Considered Ready for Market

The continuous casting of steel, to go directly from the furnace to the rolling table, is still a subject of controversy as far as details of the process go, but two of the interested parties agree that the process is ready to be used commercially.

Steel has been cast continuously for over a year by Allegheny Ludlum by methods worked out by Irving Rossi, of the Continuous Metalcast Corp. Babcock and Wilcox have cooperated with Republic Steel on a separate investigation and experimental operation.

Recent developments in the process are reported in two papers in the *Journal of Metals*. The first article, by Isaac Harter, covers the process as developed by Babcock and Wilcox and Republic Steel. Irving Rossi comments on the B & W work and gives



THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

Use RADIUM for the tough weld inspection jobs

because radium-radiographing equipment is

1. **Portable**
2. **Easily handled**
3. **No training needed to operate**
4. **Economical**

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For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

No capital investment is required to have radium-radiography available for the inspection of welds because the equipment may be rented or leased with economy.

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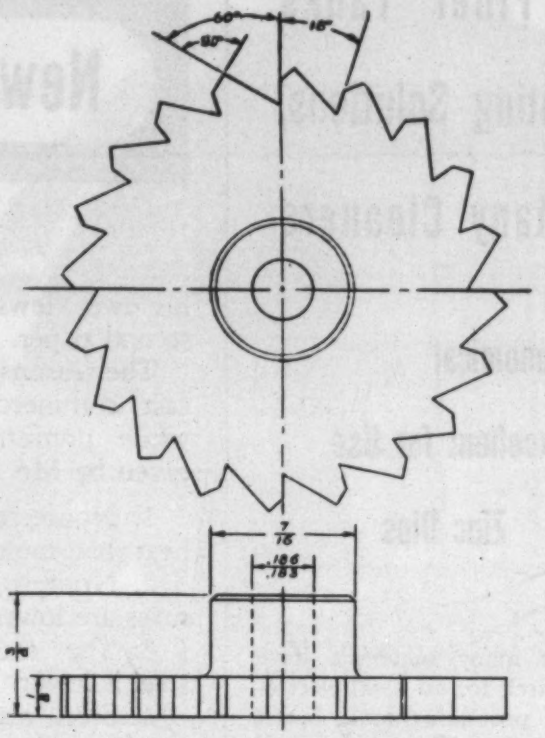

This taxi meter ratchet gear is made of powder metal by the Bound Brook Oil-Less Bearing Company, Bound Brook, N. J., from their POWDIRON (90% iron, 10% copper). Originally this part was produced as a cut gear; more recently as a die cast gear. The die casting proved too soft in application . . . the ends of the gear teeth wore considerably and deformed under slight impact loading.

The powder metal ratchet gear which actuates the dollar-and-cents indexing dial withstands the impact loading caused by the solenoid action in the taxi meter.

Powder Metallurgy offers many definite advantages for this part . . . (1) a cost saving of approximately 75% over cut gears; (2) better physical characteristics than the die-cast gear; (3) uniform tooth form smooth and quiet in performance; (4) low cost reproduction of difficult tooth angle; (5) closer tolerances than the die casting can hold; (6) freedom from deformity in service.

Simple gears as well as compound gears are adapted for powder metal production. If you use gears in quantity, Stokes can advise you if powder metallurgy offers production savings for you . . . even though we do not make powder metal parts . . . only the presses for producing the parts.

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New Glass Fiber Tanks Ideal for Plating Solutions, Acids and Many Cleaners

Strong, Light, Economical PLA-TANK (T) Excellent for Use with Luster-on® Zinc Dips

Through the years many materials have been tried in the search for an ideal electroplater's or chemical processing tank. Latest of these is Fiberglas ® impregnated and bonded with resins and molded into a seamless one-piece tank.

Sole sales rights on these new tanks for metal finishing, treating and chemical processing have been assigned to Chemical Corporation, 60 Waltham Avenue, Springfield, Mass.

According to the company's Metal Finishing Department, the new PLA-TANK (trademark under which it will be sold) is strong enough for a man to jump on, light enough to be handled easily, resistant to enough acids, plating solutions, emulsion cleaners and similar organic compounds to be highly versatile, inexpensive enough to be very competitive, and available enough to permit standard sizes to be delivered in under thirty days.

PLA-TANK Fiberglas tanks are suggested for most of those uses which have previously required stainless steel, plastic or rubber-lined tanks, acid-proof stoneware or crocks. In case of severe physical damage, the PLA-TANK may be quickly patched on the job in a matter of minutes.

Because of the newness of the product all literature is on a dated bulletin basis with new facts being released as soon as they are reported and verified. Available without cost are general descriptive sheets on PLA-TANKS, list of current sizes and laboratory report on acids and other solutions tested as to corrosive attack.

Chemical Corporation suggests that its PLA-TANKS are specially well suited for holding its LUSTER-ON Bright Dip and newest LUSTER-ON Olive Drab Dip for use on zinc-plated work. These finishes have gained added significance from recent NPA bans on use of cadmium and nickel. Although the Olive Drab is sold for United States Government orders only, the LUSTER-ON Utility-15 and -25 Bright Dips are still being offered for 1951 on an allotment basis to new customers who wish to convert to zinc and Luster-on for their civilian goods.

Free data sheets will be sent to those requesting them and engineering consultation is available for conversions. Inquiries on PLA-TANKS or LUSTER-ON should be addressed to Chemical Corporation, 60 Waltham Avenue, Springfield, Mass.

(ADV.)

News Digest

his own views on the subject in the second paper.

The reasons that steel has not been cast commercially by this method while nonferrous metals have are given by Mr. Harter as:

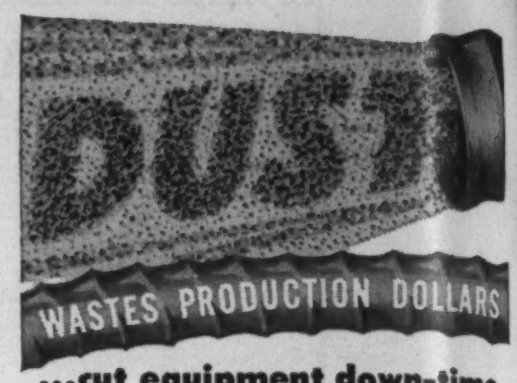
1. Nonferrous metals contain less heat than molten steel.
2. Nonferrous pouring temperatures are lower.
3. The thermal conductivity of steel is lower.
4. Steel must be cut faster than nonferrous metals because of its lower price.
5. Molten steel dissolves or erodes all known materials.

Mr. Rossi takes issue with several of these points. He contends that the thermal conductivity of steel is no bar to continuous casting; the limitation in achieving a high casting rate is the inefficiency of the mold and cooling system in taking away the heat as fast as the steel will give it up. He also claims to have found materials that will withstand the erosion and heat of steel.

The Babcock and Wilcox continuous casting mold is an open-end, vertical brass tube, cooled by high-velocity water flowing downward at 60 mph over its outer surface. Heat transfer rates are about 50 times those in a modern boiler furnace. During the cast, a small amount of inert gas, argon, and a minute quantity of combustible oil are continuously fed into the upper end of the mold to exclude and absorb oxygen. The solid casting moves out of the lower end of the tube at a speed that is controlled by spring loaded rolls operating as a running brake. To start the cast, a close-fitting head is put up into the tube on a bar and the first metal is poured on top of this as it moves down the tube.

The Continuous Metalcast process for Allegheny Ludlum is roughly similar. They bring water into the space formed between the casting and the mold as the steel shrinks, however, instead of keeping it on the outside of the mold. Steam is not formed and more efficient cooling is obtained.

B and W thinks that an x-ray apparatus to control the pouring and the metal level in the mold is a necessity. The heat is considered too intense and the control too critical for manual operation. The Continuous Metalcast Corp., on the other hand,



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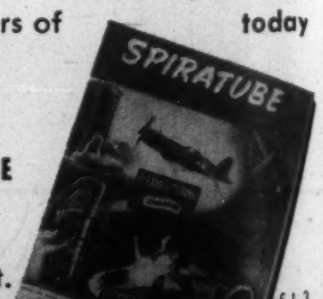

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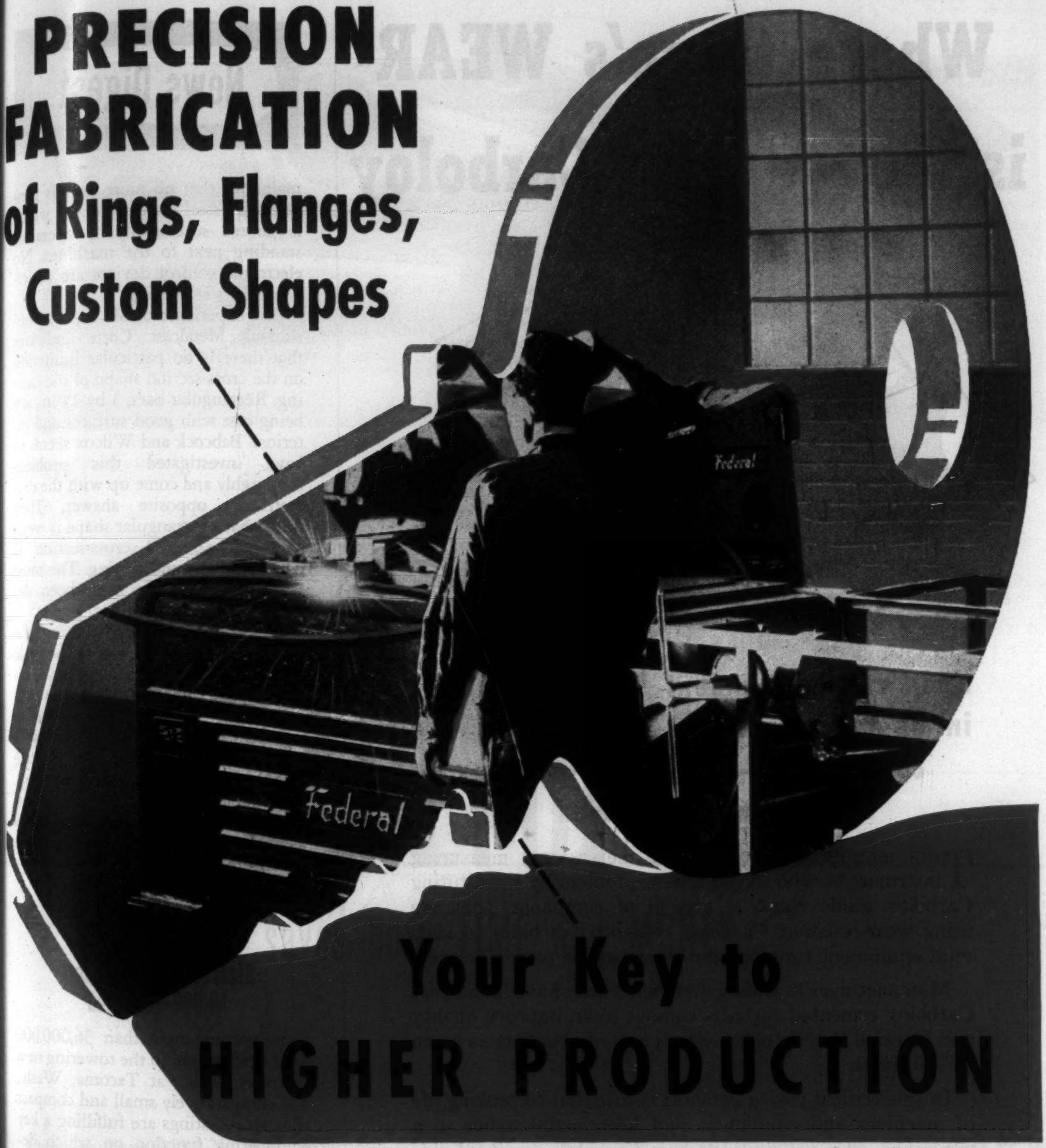

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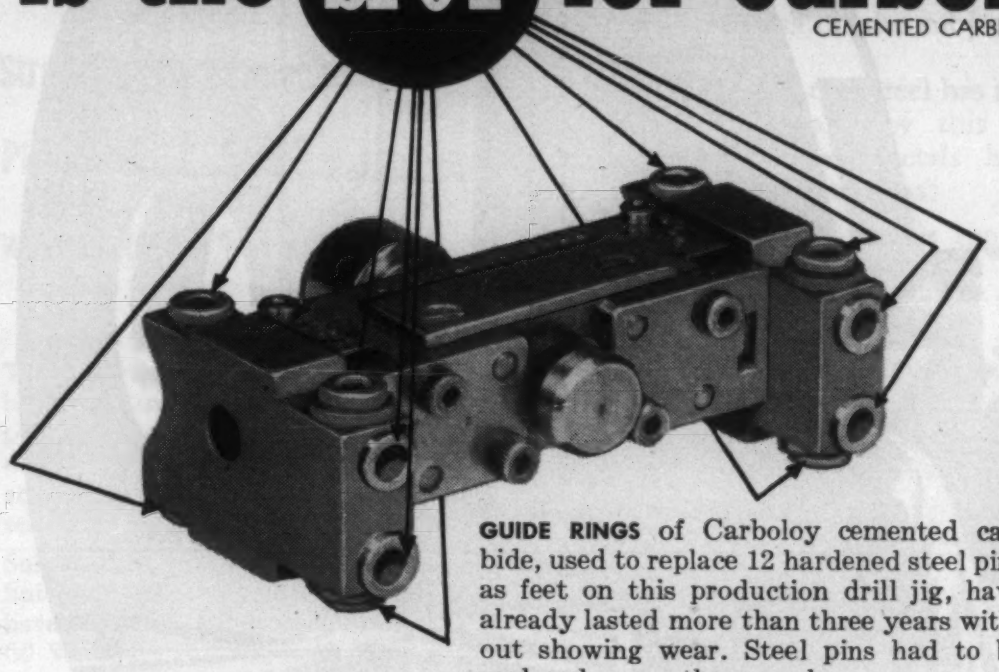

GUIDE RINGS of Carboloy cemented carbide, used to replace 12 hardened steel pins as feet on this production drill jig, have already lasted more than three years without showing wear. Steel pins had to be replaced every three weeks.

Keep vital equipment like this drill jig in operation, reduce maintenance and costly down-time with Carboloy cemented carbides

THIS manufacturer of electric meters and measuring instruments, who solved a wear problem by substituting Carboloy guide rings, is typical of companies that are using wear-resistant Carboloy cemented carbides to keep vital equipment running, and operating at peak efficiency.

Manufacturers in widely diversified lines have found that Carboloy cemented carbides combat wear, improve quality and increase the life of machine parts or products as much as 100 times.

In this critical period, when it is essential to prolong life of machines and equipment and keep maintenance to a minimum, why not find out how Carboloy cemented carbides can help you do the job? Write: Carboloy Company, Inc., a General Electric Affiliate, 11161 E. 8 Mile Street, Detroit 32, Michigan.

***Positively* reduces wear**

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maintains that no more heat is generated by steel than by copper which is poured successfully by operators standing next to the machines. No electronic control devices are anticipated for steel casting.

The experience of Mr Rossi's Continuous Metalcast Corp. indicates that there is no particular limitation on the cross-section shape of the casting. Rectangular bars, 3 by 15 in., are being cast with good surfaces and interiors. Babcock and Wilcox seems to have investigated this problem thoroughly and come up with the diametrically opposite answer. They think that a rectangular shape is weak and that an oval cross-section is needed for a sound casting. The most satisfactory oval has even been determined experimentally.

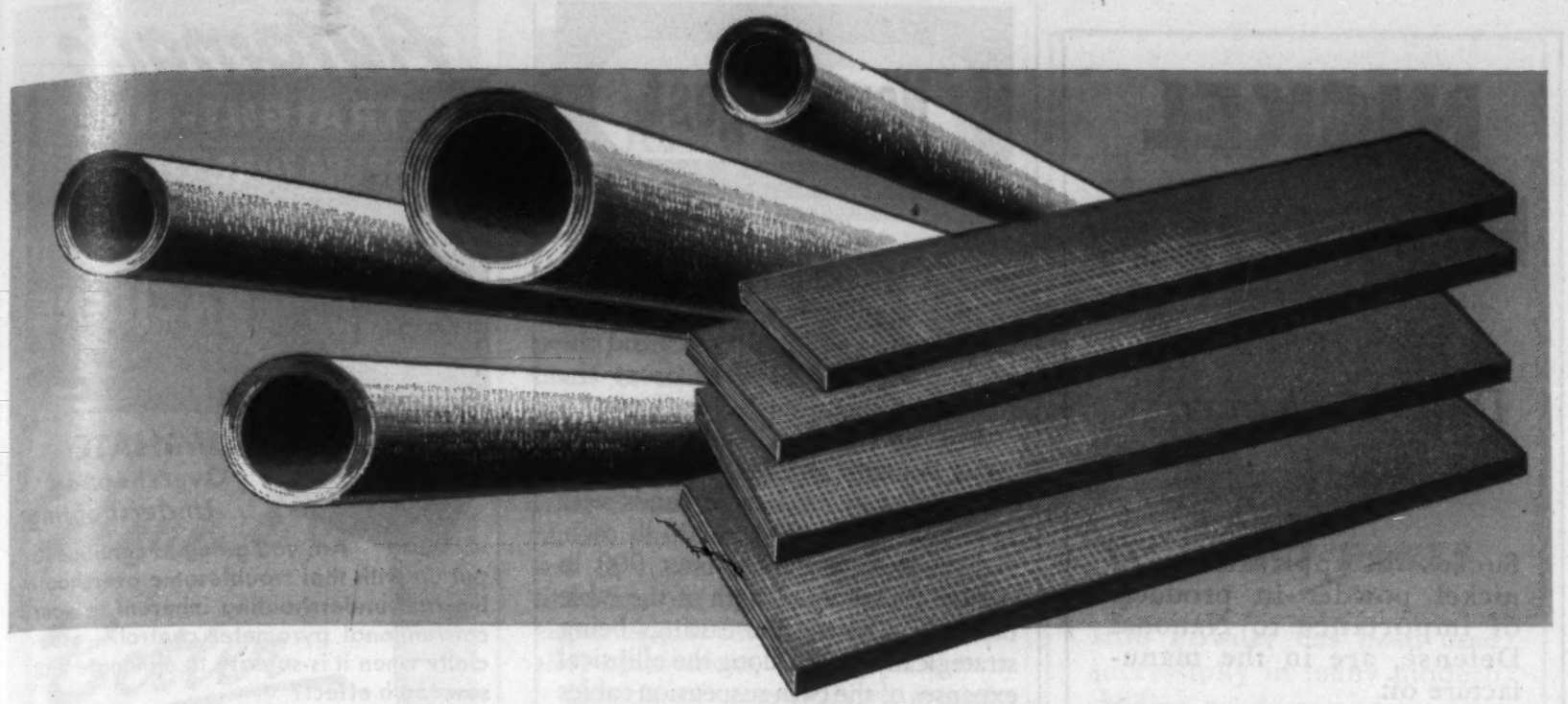
B and W is set on pouring the molten steel from the top of the ladle with a device to catch slag. This is required, they think, to maintain a uniform flow, which the fluid pressure variation with the level in the ladle and erosion of the refractory nozzle would disturb in bottom pouring. Continuous Metalcast has run a brass machine continuously for two months using bottom pouring, and the same procedure is visualized for steel.

Steel Castings Support 18,000-Ton Load

Supporting more than 36,000,000 lb of dead weight in the towering new Narrows Bridge at Tacoma, Wash., 366 comparatively small and compact alloy steel castings are fulfilling a key engineering function on which depends the safety and stability of the massive man-made monument to men and materials.

Linking the Tacoma-Seattle area with Bremerton and the majestic country of the Olympic Peninsula, the $14,000,000 bridge is the third longest suspension span in the world. More than 16,000 tons of structural steel alone were used in the 29-month job of erecting the mile-long structure. Twin towers rising 502 ft above the waters of Puget Sound carry the 201/4-in. dia cables that support the 4-lane roadway; and here it is that alloy steel cable band castings were specified to carry the immense load.

Comprising a relatively light ton-



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- **ARMOR PIERCING SHELLS**
- **SPLIT BEARINGS**—*for jeeps, tanks, etc.*

These uses may suggest other possibilities in new products now being designed, or developed.

PLASTIC METALS produces a wide variety of grades of nickel powder featuring—

1. High chemical purity
2. Particle size distribution as required, ranging from 20 mesh to finer than 20 microns
3. Irregularly shaped, or spherical particles
4. Range of apparent densities
5. Uniformity of quality from lot to lot

We will be glad to talk to your Purchasing, Research or Engineering Staff about the manner in which nickel powder might be made to serve your needs.

We also produce Iron Powder, Magnetic Iron Oxide, Manganese and Silicon Powders.

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DIVISION OF THE NATIONAL RADIATOR COMPANY
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News Digest

nage of 329,400 lb in comparison to overall weight, the 366-cable band castings are employed to suspend the bridge bed and roadway from the massive suspension cables.

Produced to special order by the Atlas Foundry and Machine Co., Tacoma, the cast steel cable bands vary in weight from 400 to 2400 lb each, average weight being about 900 lb per band. Average length of the cable bands was 34 in., the castings being strategically placed along the elliptical expanses of the twin suspension cables to sustain the major calculated loads involved. All cast in halves, the band castings subsequently were machined in the bore and face, and a caulking groove was machined in each end.

Substitutions Considered for Armed Forces Specifications

A critical analysis of equipment and material being procured by the Armed Forces is under way by the Munitions Board in the search for specifications which will permit use of substitutes wherever critically-short materials are used. Chairman John D. Small has announced research and development agencies are cooperating to the fullest possible extent.

Examples of the types of materials which can be replaced by less critical substitutes, as well as process changes which might allow for conservation, are: suitable plastics for metals; synthetic for natural rubber; pressed, powdered or extruded parts to replace forged parts; printed electronic circuits instead of wired circuits; paints or other protective coatings instead of metal plating; and stamped parts instead of machined parts.

Conservation is also possible through redesign of end items to allow for less dependence on critically-short materials. Such raw materials as aluminum, chromium, lead, rubber, tin, wool and zinc are examples. Each one is currently being stockpiled by the Munitions Board against expected short supply in the event of full mobilization.

Steel cartridges can be used instead of brass ones for certain calibers of ammunition. Silk must be stockpiled because it is the only entirely satisfactory material known so far for use in high-endurance powder bags. But

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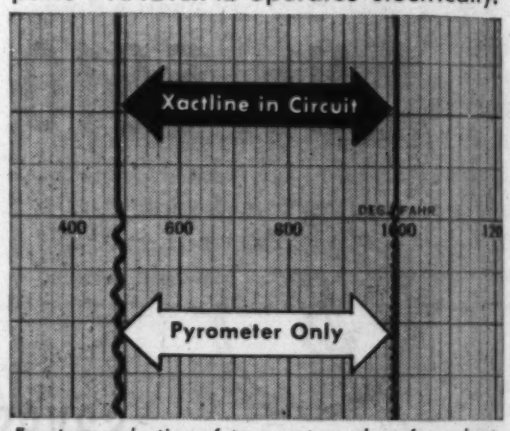
"STRAIGHT-LINE" TEMPERATURE CONTROL *with* **XACTLINE**

ELIMINATE *Overshooting Undershooting*

Are you going to continue to put up with that troublesome overshooting and undershooting inherent in your conventional pyrometer control—especially when it is so easy to eliminate that saw-tooth effect?

Put XACTLINE in the control circuit. XACTLINE anticipates the temperature changes—before they occur. And too, it nullifies the varying amounts of thermal lag, residual heat, and mechanical lag—producing a short on-off cycle resulting in "Straight-Line" temperature control. This performance is possible because there is no dependence upon mechanical parts—XACTLINE operates electrically.



Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

XACTLINE is applicable to any indicating or recording pyrometer control of the millivoltmeter or potentiometer type. It should be used wherever close temperature control is required—any type of electrically heated oven, furnace, kiln, injection molding machine, and fuel-fired furnaces equipped with motor-operated or solenoid valves.

XACTLINE is a complete unit. No adjustment or coordination with the control instrument is required regardless of the size of the furnace, length of the heating cycle, or size of the load. Installation is very simple—can be either flush or surface mounted.

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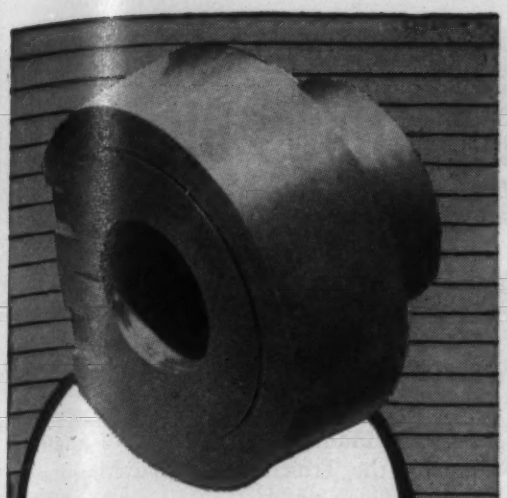

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Write for literature or send blueprints, conditions of operation and other data for quotations and recommendations as to alloys.

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substitutes, such as cotton, rayon, nylon, orlon, robia, wool, treated fibers or other fibrous materials, are being studied to determine suitability for this special use.

Nickel and chromium are used extensively in alloy steels, but redesign of equipment may allow for use of less of these steels, and studies in titanium, one of the most abundant elements, may reveal possibilities for alloy substitutions.

Criteria of acceptability of end items will not necessarily be lowered in order to allow substitutes, it is pointed out, since some original specifications were made when material shortages were not a problem. However, where performance can satisfactorily be lowered economically, every effort will be made to find suitable noncritical materials.

Substitute materials specifications will be included in the cataloging program, which entails the detailed description of the thousands of military equipment items under procurement or supply programs. The "materials-swapping" effort will have a tremendous impact on military supply management.

News of Engineers

William G. Gerstacker has joined The Colonial Iron Works Co. as chief engineer. He previously was associated with The V. D. Anderson Co. as manager of its Solvent Extraction Div.

Allis-Chalmers Manufacturing Co. has announced several changes within its organization. *William A. Roberts,* executive vice president in charge of the Tractor Div., was elected president of the company, to succeed *Walter Geist,* who died of a heart ailment. Pertaining to the General Machinery Div., *W. C. Johnson,* executive vice president in charge of the Division, was named executive vice president for the entire company. *J. L. Singleton,* vice president and director of sales, is now vice president in charge of the Division. *Fred Mackey,* general works manager, becomes vice president in charge of manufacturing. In the Tractor Div., *R. S. Stevenson,* general sales manager, was elected vice president in charge of the Division. *A. W. Van Hercke,* director of engineering, was named vice president in charge of engi-

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Iron Powder has been used successfully in many modern civilian products and in military materiel during the past World War. This has attracted the renewed interest and consideration of Ordnance designers and manufacturers of products essential to the present National Defense program.

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- **GUNS, MISSILES**
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- **RADIO, RADAR, SONAR AND OTHER COMMUNICATION AND DETECTION EQUIPMENT**—*electronic cores and magnets*

PLASTIC METALS, the leading manufacturer of iron powder in this country, with a practical experience background of 17 years in the development and production of metal powders has extensive electrolytic, reduction, pulverizing, annealing and screening facilities and is expanding its production capacity constantly to serve the increasing demand.

If you are interested further, may we suggest that you get in touch with us for a more detailed discussion of Iron Powder possibilities.

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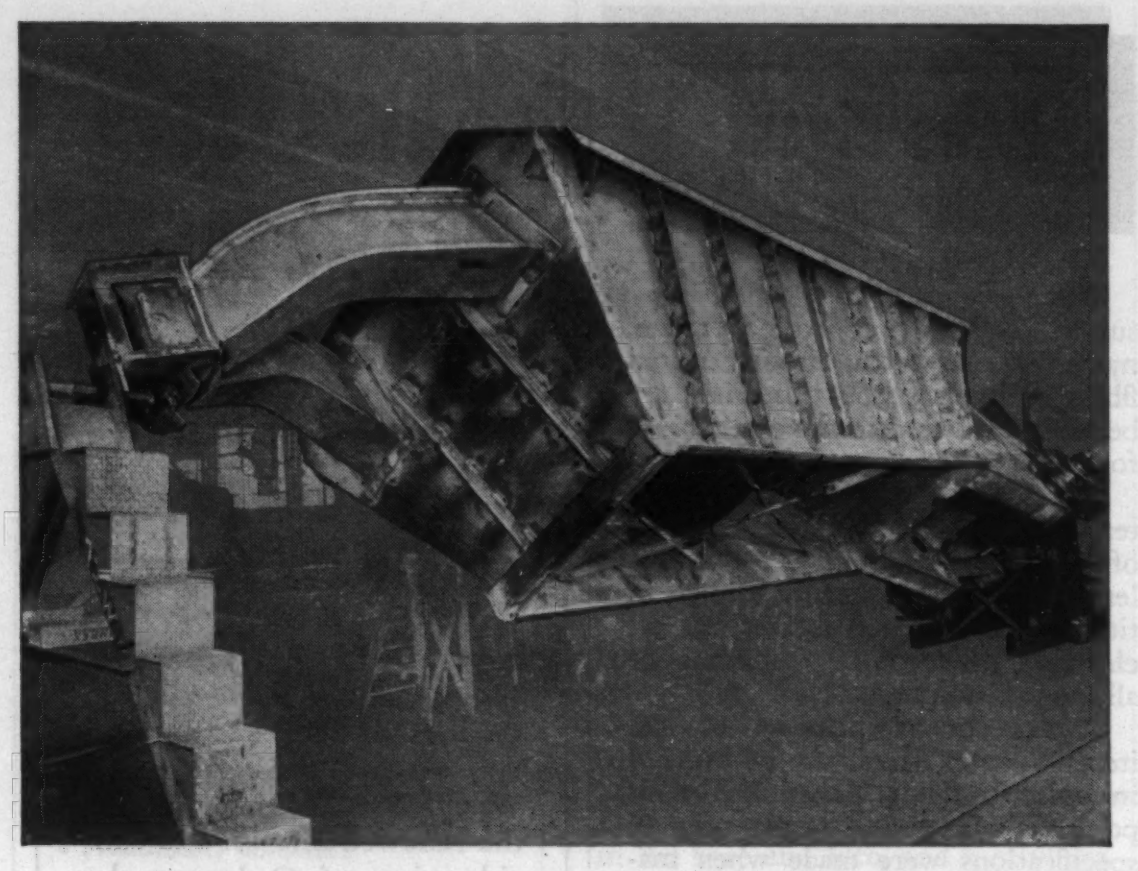

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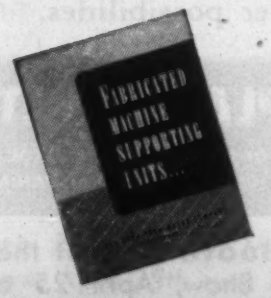

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neering. And finally, *John Ernst,* general works manager, is now vice president in charge of manufacturing.

Charles Bangert, Jr. was promoted from assistant manager to manager of engineering for the Trumbull Electric Manufacturing Co.

The Towmotor Corp. has announced the addition to its staff of *E. C. Iverson* in the capacity of chief engineer.

Robert H. Owens was elected president and general manager of Roots-Connersville Blower Corp. He succeeds *John Avery,* who died suddenly in January. At the same time, *Ralph R. Newquist,* vice president in charge of sales, was named executive vice president.

The promotion of *Sheldon Dale,* service manager, to the newly created position of director of research and development for Cory Corp. has been announced.

Ernest S. Theiss succeeds *W. W. Warner* as chief engineer of the Davey Compressor Co. Mr. Theiss formerly served as assistant chief engineer, and Mr. Warner was recently made a vice president.

Loftus Engineering Corp. elected *W. A. Morton* as president, to succeed *Fred H. Loftus,* who died suddenly at the age of 56.

Edward A. Ledeen has joined the Federal Steel Warehouse Corp. as chief engineer. For the past two years Mr. Ledeen served as chief of the program analysis branch of the aircraft scheduling unit at Wright-Patterson AFB.

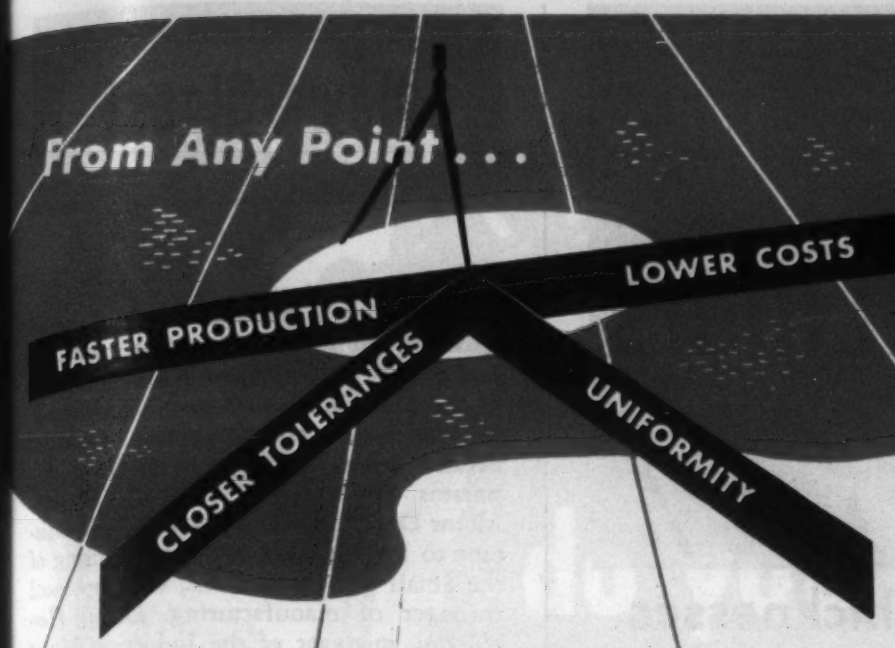
The Plaskon Div. of Libbey-Owens-Ford Glass Co. has promoted *Dr. Harold Hoppens* to the position of associate director of research. Dr. Hoppens will continue in charge of coating resin's research. It was also announced that *John A. Morse* joined the Plaskon Div. as manager of operations, having previously been an associate of Worden & Risberg.

Eric O. Melmer has joined the Jervis B. Webb Co. of California as secretary and chief engineer.

The Pyrene Manufacturing Co. elected *Wallace B. Phillips* president of the concern, to succeed *Edward J. Waring,* who retired after almost 40 years of service. Mr. Phillips has been associated with the Pyrene organization since 1913.

Gordon E. Hann was named vice president in charge of research and manufacturing of the Tremco Manufacturing Co. Mr. Hann has been connected with Tremco since 1932.

General Electric Co. has announced changes in personnel throughout its divisions. In the Large Apparatus Div., *Francis K. McCune* was appointed manager of engineering, to succeed *Ernest E. Johnson,* now general manager of the General Engineering Laboratory. *William E. Johnson* assumes Mr. McCune's former position of



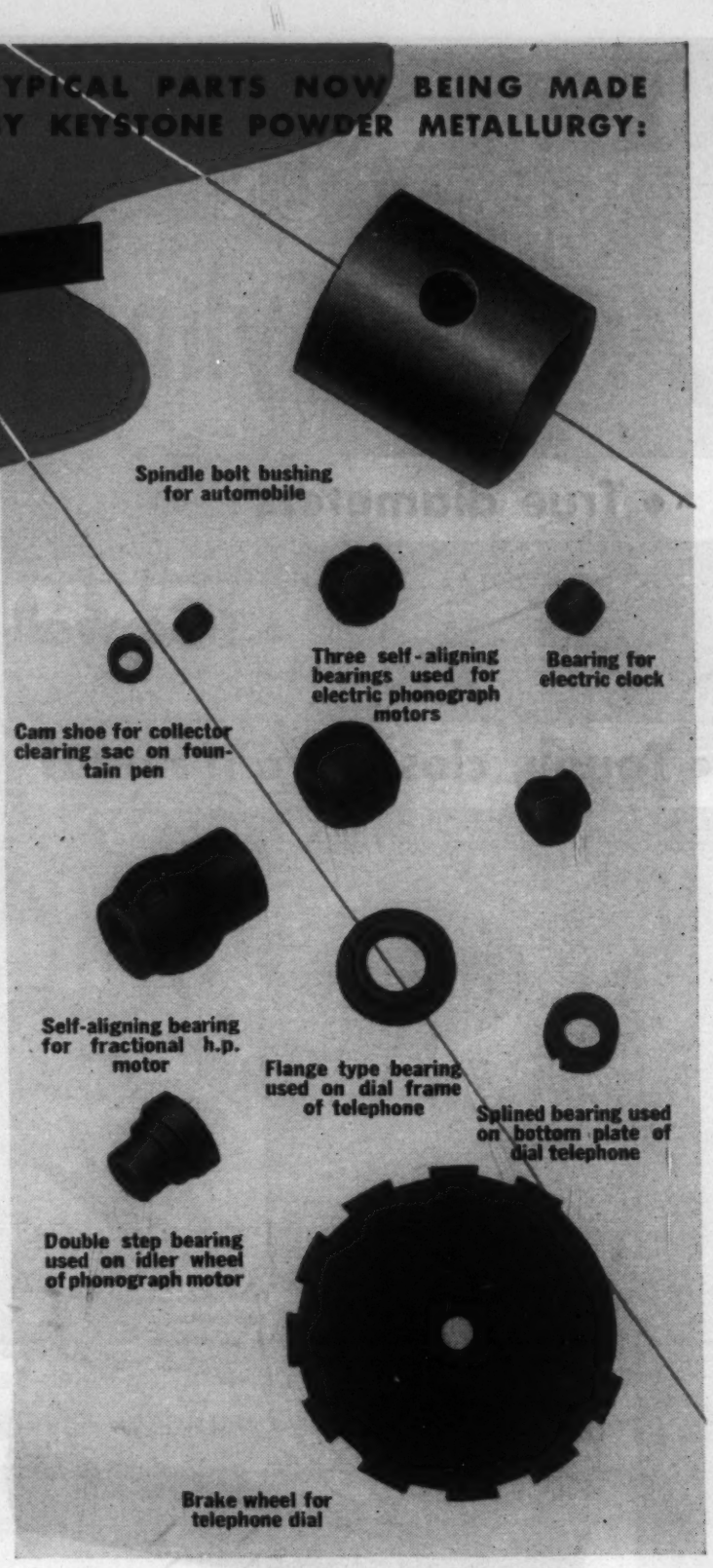
it will pay you to investigate

KEYSTONE

POWDER METALLURGY

for your

PARTS REQUIREMENTS


TYPICAL PARTS NOW BEING MADE BY KEYSTONE POWDER METALLURGY:
Spindle bolt bushing for automobile
Three self-aligning bearings used for electric phonograph motors
Bearing for electric clock
Cam shoe for collector clearing sac on fountain pen
Self-aligning bearing for fractional h.p. motor
Flange type bearing used on dial frame of telephone
Splined bearing used on bottom plate of dial telephone
Double step bearing used on idler wheel of phonograph motor
Brake wheel for telephone dial

MANY small parts are now being made by Keystone Powder Metallurgy that formerly could be produced only by costly hours of machining, milling, slotting, grinding, and drilling. The advantages of this method may be summarized as follows:

LOWER PRODUCTION COSTS

Keystone Powdered Metal Parts are being produced at high rates of speed (200 to 1600 parts per hour) with pronounced savings in both time and material due to the elimination of tedious machining operations. These savings are passed on to you, the product manufacturer.

IMPROVED PERFORMANCE

Keystone Powdered Metal Parts are maintained to closer tolerances and with greater dimensional uniformity than is ordinarily practicable with machine-made parts . . . permitting increased speed of final assembly. Special physical properties are attained by combinations of metals that do not alloy by melting . . . thereby meeting a wide variety of performance specifications.

From the standpoint of economy and customer satisfaction, Keystone Powdered Metal Parts are worthy of consideration for use in your products. Our Catalog, "Powder Metallurgy," contains most of the answers to your questions. Write for your copy.

POWDER METAL PARTS DIVISION

KEYSTONE CARBON COMPANY

1935 STATE ST., SAINT MARYS, PENNA.

MANUFACTURERS OF PRECISION MOLDED PRODUCTS

DURASPUN

18-8 Cylinder Liners

• True diameters

• True wall thicknesses

• Tough, close-grain metal

Are you thoroughly familiar with the superior qualities of "centrifugally cast" high alloys . . . such as these cylinder liners, for example?

Centrifugally cast metal is exceptionally uniform, close-grained and strong. It is free of pits and pockets. It is capable of passing very rigid tests. And the practical advantage is that as long as there is a central circular hole, almost any outside shape can be cast. Some of our customers want their castings centrifugal even though considerable boring and other machining is necessary to finish the piece.

We recommend our centrifugal casting service if your requirements call for the characteristics outlined above. Our high alloy foundry is modern in every respect and staffed by metallurgists and foundrymen of many years' experience with both centrifugal and static castings.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.

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News Digest

assistant general manager of the Nucleonics Dept. *John W. Belanger,* assistant general manager, was named general manager of the Division. Simultaneously, *Nicholas M. DuChemin,* assistant general manager, became general manager of the Small Apparatus Div. In the Small & Medium Motor Divs., *Francis J. Boucher,* staff assistant to the manager of manufacturing of the Small Apparatus Divs., was appointed manager of manufacturing. *Elliott Harrington,* manager of the Induction Motor Sales Div., was promoted to vice chairman and secretary of a newly-established Defense Projects and Priorities Committee of the Divisions. In the Chemical Dept., *Robert L. Gibson,* assistant general manager, was promoted to general manager. *Robert L. Teeter,* formerly a chemical project engineer for the Tennessee Eastman Corp., has joined GE as manufacturing engineer for the Chemicals Div., while *Alfred R. LaCasse,* project engineer, was named manufacturing analyst for the Division. *Joseph C. Mogavero* was promoted to facilities engineer of the Manufacturing Div. and *Earl F. Arnett* was appointed in charge of the Pittsfield Chemical Process Development Section. In the General Engineering Laboratory, *Dr. Martin A. Edwards,* associate engineer in charge of the Laboratory's technical division, is now engineering manager. *Dr. Ferd E. Williams* was appointed head of the Light Production Div. of GE's Research Laboratory, while *Dr. Leroy W. Apker* becomes head of the new Semi-Conductors Div. Three executive vice presidents were also elected. They are *Henry V. Erben,* vice president and general manager of the Apparatus Dept; *Hardage L. Andrews,* vice president and general manager of the Appliance & Merchandise Dept.; and *Roy W. Johnson,* vice president and general manager of the Affiliated Manufacturing Companies Dept. And finally, *David C. Prince,* vice president, was named to the president's staff, while *Harry A. Winne* assumes the responsibility formerly held by Mr. Prince for the General Engineering Laboratory.

Alloy Rods Co. recently elected the following new officers: *E. J. Brady,* president and chairman of the board; *M. G. Sedam,* executive vice president; *C. R. Carlin,* vice president in charge of production; *R. K. Lee,* vice president in charge of research and engineering; *W. D. Himes,* treasurer; and *H. L. Weaver,* secretary and assistant treasurer.

Allan F. Dill was promoted to the newly-created post of defense regulations coordinator for the American Steel & Wire Co.

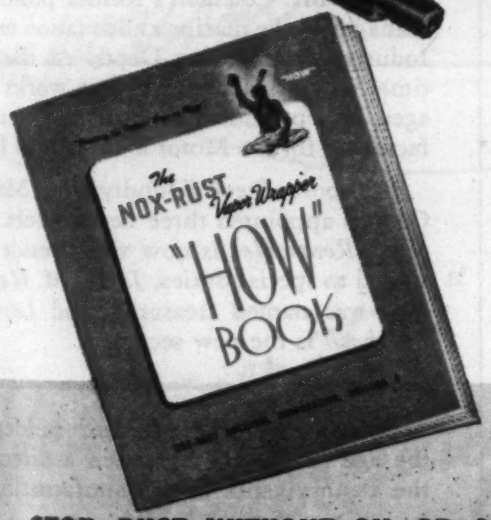
Electrofilm Corp. has appointed *W. G. Andrews* to the position of executive vice president and general manager. Mr. Andrews previously served as district manager for the Bastian-Blessing Co.

F. H. Schroeder, vice president and director of the Lee Higginson Corp., has been

Do your beautifully machined parts and machines reach your customers pitted or stained? Then you've a *RUST* problem, a needless cost! Better call in a Nox-Rust representative. He's a specialist in rust prevention. He will show you how to properly protect metals (1) between operations, (2) in storage, (3) during shipment, domestic or export.

Are you bidding on government orders which require a rust preventive coating? Then, by all means see the Nox-Rust representative. He will give you complete information regarding the coatings required. What's more, he will show you how to apply them. Nox-Rust specializes in the production of Federal Specification coatings and oils.

SEND FOR FOLDER LISTING FEDERAL RUST PREVENTIVE SPECIFICATIONS AND NOX-RUST PRODUCTS CONFORMING TO EACH.



STOP RUST WITHOUT OIL OR GREASE

Have you heard about the new way of packaging parts and machines without the use of oil or grease-type rust preventive coatings? Do you know that now you can receive parts from your suppliers that are "factory-fresh"—sparkling clean—free of rust or grease—ready for immediate assembly or use? Send for this important book of case histories which shows you how others have eliminated the slushing and degreasing problem—how you can apply this new method in your own operations. No obligation. No cost. It's from Nox-Rust—Headquarters for Rust Preventive Products.

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Rust Prevention Division
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Chicago 8, Illinois
BALTIMORE PHILADELPHIA
DETROIT SAN FRANCISCO

SYNTHETIC SAPPHIRE *for*

Resistance to Wear

Outlasting hardened steel and cemented carbides 2 to 5,000 times

Resistance to Friction

Affording very low friction surfaces due to hardness and surface continuity.

Resistance to Heat Distortion

Retention of form at temperatures up to 1,000°C.

Retention of Insulating Properties

Excellent dielectric properties over a wide range of temperatures.

LINDE Synthetic Sapphire is available in a variety of forms. It can be polished by flame or ordinary diamond polishing; it can be formed and bent by flame. Polished sapphire surfaces keep free of dirt, and in many anti-friction applications, need not be lubricated.

The experience that LINDE engineers have in applying sapphire to industrial processes may be of help to you. Call or write the LINDE office nearest you. Get your copy of the booklet, "LINDE Synthetic Crystals For Industry." Ask for Form 7560.

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News Digest

elected a director of Standard-Thomson Corp.

Fleet Admiral *William F. Halsey, Jr.* (USN retired) was named president of International Telecommunication Laboratories, Inc., an associate of the International Telephone and Telegraph Corp.

The Vanadium Corp. of America has announced the addition to its staff of *Roy F. Hancock,* who will serve as assistant to the vice president in charge of sales. Mr. Hancock previously was associated with the Carnegie-Illinois Steel Corp. as manager of the Eastern alloy steel sales.

Robert T. Haslam was elected to the board of directors of Worthington Pump and Machinery Corp. Until recently, Mr. Haslam was a vice president and director of Standard Oil Co. (New Jersey).

The Electric Furnace Co. has named *Richard E. Coe* assistant to the president. Mr. Coe has been associated with the North American Manufacturing Co. as district manager.

H. C. Coleman was promoted to the position of manager of the Industry Engineering Depts. of Westinghouse Electric Corp. He succeeds *F. R. Benedict* who was recently assigned new duties with the Company's Atomic Power Div. *S. A. Haverstick* assumes Mr. Coleman's former position of manager of the marine and aviation section, Industry Engineering Depts. At the same time, *W. G. Miller,* assistant works manager, was promoted to manager of manufacturing for the Motor and Control Div.

Birdsboro Steel Foundry and Machine Co. has appointed three new officers. *Robert F. Rentschler* is now vice president assigned to special duties; *James M. Heppenstall* was named treasurer; and *Lester E. Leinbach* is the new secretary.

Yellott F. Hardcastle died suddenly at the age of 67. He had been a director of the Pennsylvania Salt Manufacturing Co.

The International Nickel Co. of Canada, Ltd., has announced the death of *Robert Crooks Stanley* at the age of 74. Mr. Stanley was chairman of the board of directors.

Russell L. Peck, refractories engineer for Norton Co., was killed in an automobile accident in Tallulah, La.

News of Companies

Reynolds Metals Co., Louisville, plans to build an aluminum reduction plant in the Corpus Christi, Tex., area, which will have the capacity to produce 150,000,000

Design Department:
Let's look at plastics for packaging our product
J.B.

These advantages would be important to us.

"Idea generators" sounds interesting. Will you write for it?

Economical, handy, protective vials for hypodermic needles (above)...and scores of other types of products (left) are injection-molded of Lustrex styrene plastic by Celluplastic Corporation, Newark, N. J.

Injection-molded vial freezes habit-itis*

Hypodermic needles and phonograph cartridges...pharmaceuticals and cosmetics... saccharin and styptic pencils...hardware and denture materials—all these and many other products today are being *profitably* packaged in vials made of Lustrex.

"*Profitably*," because fast, accurate, one-shot injection molding of Lustrex styrene cuts production time and expense. Because lightweight Lustrex gives more units per pound of material, lowers shipping costs. Because stronger, more durable vials of Lustrex mean easier handling, less breakage and fewer returns.

Lustrex styrene is only one in a whole *family* of Monsanto plastics—each with its own individual chemical and physical characteristics—that might help you make - or sell—a better product at lower cost.

For new plastics application ideas, send for your free copy of Monsanto's new booklet, 'Idea Generators.' Write: MONSANTO CHEMICAL COMPANY, Plastics Division, Room 1104, Springfield 2, Mass.

Lustrex: Reg. U. S. Pat. Off.

"We 'put the freeze' on HABIT-ITIS* when we decided to package our hypodermic needles for dentists... safely, conveniently, profitably... in Lustrex styrene plastic," says E. L. Hoskins, President, Cook-Waite Laboratories, Inc., New York and Windsor, Ont.

*HABIT-ITIS—definition:—Habit-thinking; following familiar patterns of action from habit.

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CHEMICALS AND PLASTICS

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...WHICH SERVES MANKIND

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☐ Please send me Monsanto's new booklet, "Idea Generators."
☐ Please send information on the whole family of Monsanto plastics.

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Company _____

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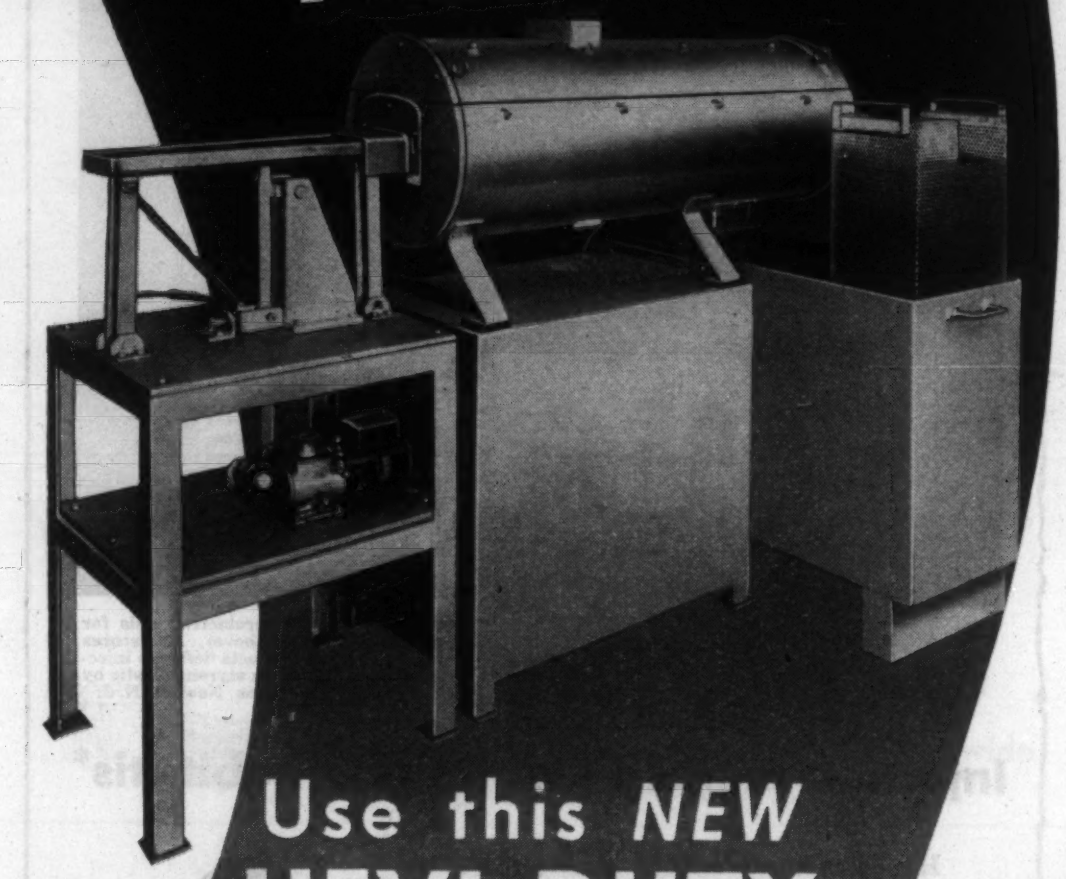
FOR INCREASED PRODUCTION



Use this NEW HEVI DUTY SHAKER HEARTH FURNACE

DESIGNED specifically for production heat treating of small parts, these Hevi Duty Shaker Hearth furnaces have proved themselves to be versatile in their application.

Bright Carburizing, Cyaniding and Hardening processes are easily performed using the proper atmosphere in the alloy retort. Close control of case depths can be maintained.

Because the work drops directly into the quench tank a few pieces at a time, a most satisfactory quench results with a minimum of quenching medium.

Write for bulletin HD-850.

HEVI DUTY ELECTRIC COMPANY

HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY

DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS

MILWAUKEE 1, WISCONSIN

News Digest

lb. of aluminum pig annually. The plant is expected to be in operation by the end of this year.

The first manufacturers of investment materials for industrial use to be established in Cleveland is *Pre-Vest, Inc.*, located at 23420 Lakeland Blvd. Claude H. Watts is president of the new concern, and Edmund E. Erndt is general manager.

A new building has been added to the East Works Dept. plant of *The Babcock & Wilcox Tube Co.* located in Beaver Falls, Pa., which will result in better service for users, fabricators and distributors of B & W Stainless Tubing.

Allied Products Corp., Detroit, has acquired all of the outstanding stock of *Michigan Powdered Metal Products Co., Inc,*. Northville, Mich. Ralph Hubbart, president of Allied Products, will also be president of the new subsidiary. John Haller, former president and founder of Michigan Powdered Metal Products, Leroy E. O'Dell and Frank H. Bishop, vice president of Allied, are all vice presidents of the new addition. W. E. Ray is secretary and J. P. Halm is treasurer, both positions presently held by the two men in Allied Products.

A three-story addition to the main laboratory building at its Experiment Station near Wilmington, Del., has been completed by *Hercules Powder Co.*

Plans have been completed for the formation of a new company in Kambara, Japan, by *B. F. Goodrich Chemical Co.*, Cleveland 15. The plant will manufacture "Geon" polyvinyl chloride, and will be staffed completely by Japanese. Principal stockholders, in addition to Goodrich, are the *Furukawa Electric Co., Ltd., Nippon Light Metal Co., Ltd.* and the *Yokahama Rubber Co., Ltd.*, all of Tokyo, Japan.

Kaiser Aluminum & Chemical Corp., Oakland, Calif., will enter into the aluminum extrusion industry upon completion of reactivating and improving a government-owned plant at Halethorpe, Md.

In order to meet increased production requirements, the *International Rectifier Corp.* has added a second story to its plant located at 6809 S. Victoria Ave., Los Angeles 43.

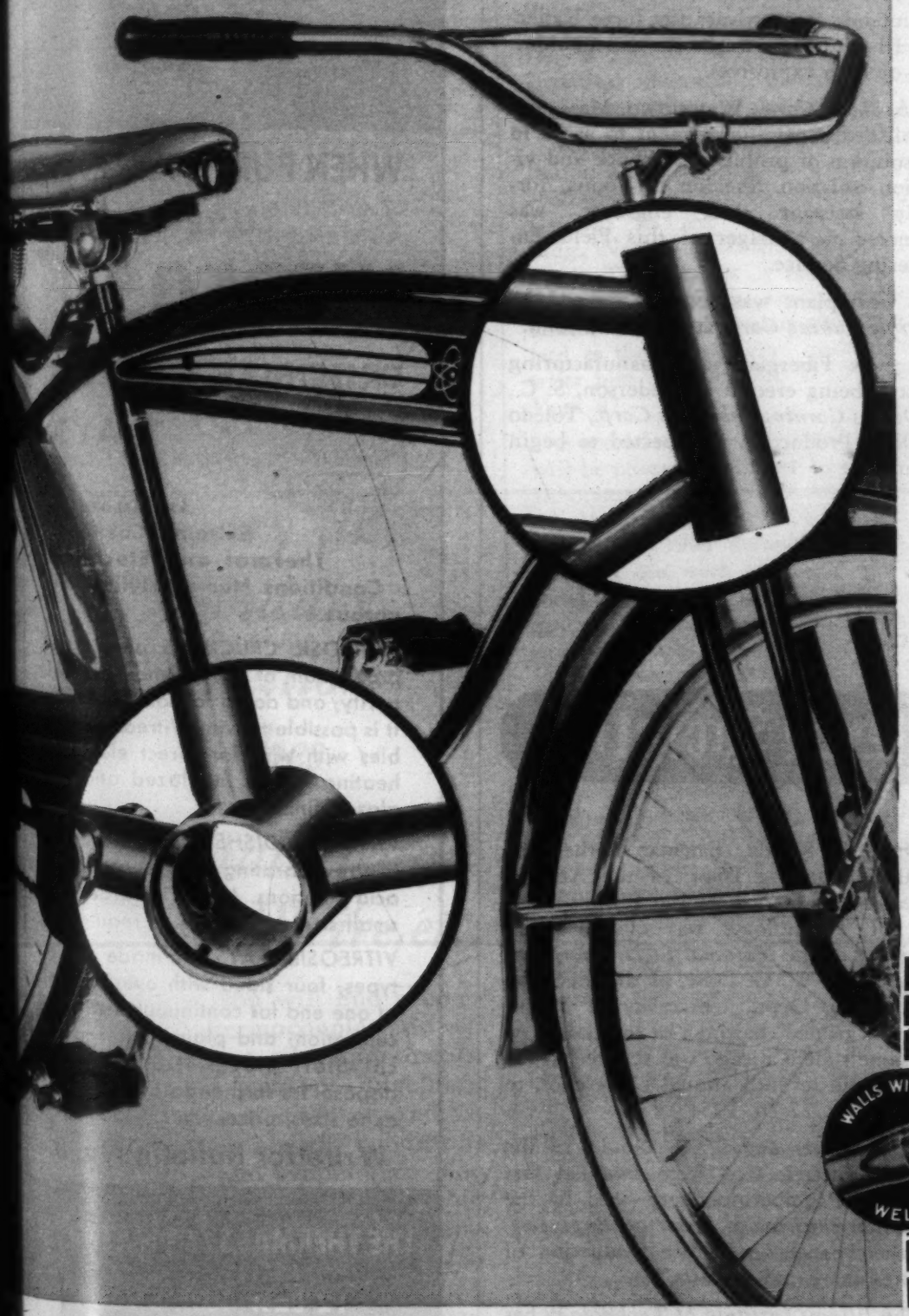
The J. M. Ney Co., Hartford, Conn., has announced the acquisition of a new plant in East Hartford, which will complement the research and engineering facilities already built around the industrial department at the Hartford plant.

The Metal Finishing Div. of the *Pyrene Manufacturing Co.* has completed its transfer from Belmont Ave., Newark, N. J., to enlarged quarters on Empire St., Newark 5.

Another foundry has been acquired by *Barnett Foundry & Machine Co.*, Irving-

Your grandfather rode a Columbia-Built bicycle

oday...it's better-than-ever...with SHELBY SEAMLESS TUBING



IN 1877, Columbia made the first bicycle ever produced in the United States. Within a short time, Columbia-built bicycles became famous throughout the world . . . and they're still famous today, 74 years later.

Columbia bicycles have this high reputation because the manufacturer is quick to adopt new fabricating methods . . . quick to utilize the finest materials for every vital part.

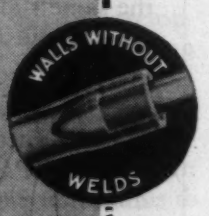
A good example is the use of high strength Shelby *Seamless* Tubing for the head tube and crank-hanger tube—the two most heavily stressed frame parts. Shelby Tubing is easy to machine *accurately*, so it simplifies bearing alignment in these critical sections.

It's strong, too. All Shelby Seamless Tubing is pierced from a solid billet of fine steel. This process is one of the most drastic forming operations in the steel business, and nothing but the best steel can withstand such treatment.

Shelby Seamless Tubing has always been famous for uniform wall strength, from one end to the other. It's so strong that many manufacturers have long used it in place of solid bar stock; and, since *the basic shape is already made*, fewer operations are necessary, rejects go down, production costs can often be cut an appreciable extent.

In planning your future program, let our service engineers help show you how to cut production time and costs with this easy-to-machine, high strength material. Draw upon the priceless experience of National Tube Company—world's largest manufacturer of tubular steel products.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(TUBING SPECIALTIES DIVISION)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



National Tube Company
Frick Building, Pittsburgh 19, Pa.

Please send me your free booklet describing mechanical applications of Shelby Seamless Steel Tubing.

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Shelby Seamless Steel Tubing

UNITED STATES STEEL

FREE Low Temperature EUTECTIC WELDING ALLOYS DATA FILE PROVES SAVINGS YOU CAN ENJOY IN MAINTENANCE WELDING

SALVAGE WELDING TIME CUT MORE THAN 90% WITH NEW Low Temperature EUTECTIC WELDING ALLOYS

When a leading research institute's tensile testing machine was overloaded, the top snapped completely off the two side members. At first, the old-fashioned conventional high heat fusion methods were tried. The entire operation—pre-heat, slow cool, etc.—consumed 48 hours in all; and, on the first day after its repair, the casting cracked wide open again, through and alongside the welding area. It seemed as though the entire casting would have to be scrapped. Before taking this costly step, Eutectic was consulted . . .

The damage was repaired permanently with EUTECTIC's BIG TEAM — CutTrode + EutecTrode 24, for cast iron. CutTrode—a new special metallic-arc oxygen-less cutting electrode first beveled the breaks, in preparation for welding. Sufficient residual heat remained from the use of CutTrode to weld the entire job without any further pre-heat. The breaks were first tack welded; then stringer beads were deposited with new EutecTrode 24. The entire job—permanently welded—was accomplished in only 4 hours—*1/12 THE ORDINARY WELDING TIME!* (Complete details and photos of this job available on request.)

"EUTECTIC Low Temperature WELDING ALLOYS" are setting new standards for production and maintenance welding everywhere. Drawbacks of conventional brazing and fusion welding—such as distortion, warping, porosities, and weld failures — are minimized or completely eliminated when you use EUTECTIC's JOB PROVED hi-tensile low melting alloys.

WRITE FOR *FREE* MAINTENANCE WELDING DATA FILE TODAY!

1940 EUTECTIC 1951

EUTECTIC WELDING ALLOYS CORPORATION
Technical Information Section
40-40 172 Street Flushing-New York, N. Y.
Independent Pioneer of the Welding Industry

News Digest

ton, N. J., this one being located in Dover, N. J.

Ehret Magnesia Manufacturing Co. has announced the completion of a new plant, located at the company's present site at Valley Forge, Pa.

Construction of a major steel plant, to be known as the Fairless Works, has been started by the *United States Steel Corp.*, New York, in Falls Township, Pa. It is believed to be the largest single steel construction project on record, since the annual productive capacity will be 1,800,000 tons.

United States Rubber Co., New York 20, intends to reactivate the huge Kankakee, Ill., ordnance works for the manufacture of high explosives.

The Barry Corp., Watertown, Mass., has established a new department to assist in the solution of problems in shock and vibration isolation. Sheldon E. Young, formerly assistant chief engineer, was promoted to manager of this Field Engineering Service.

A new plant was recently opened by *Flexible Tubing Corp.* at Guilford, Conn.

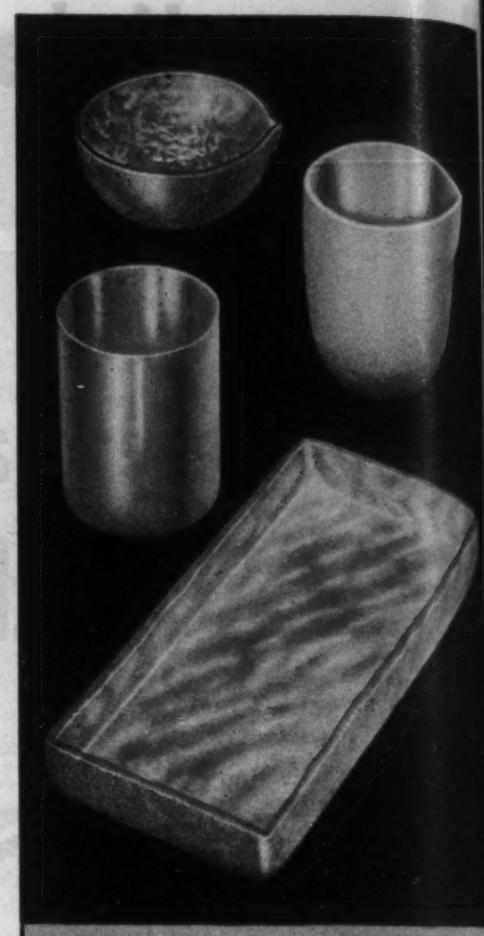
A new Fiberglas yarn manufacturing plant is being erected in Anderson, S. C., by *Owens-Corning Fiberglas Corp.*, Toledo 1, Ohio. Production is expected to begin the middle of 1951.

News of Societies

Dr. E. H. Schulz, chairman of the Electrical Engineering Dept. of the Armour Research Foundation of the Illinois Institute of Technology, was elected 1951 president of the *National Electronics Conference, Inc.* W. G. Dow, of the Electrical Engineering Dept., University of Michigan, was named chairman of the board. At the same time, Chicago was selected as the site for the seventh annual conference, to be held Oct. 22-24, 1951.

C. P. Hayes and H. R. Gould, of the General Electric Co., were awarded first prize in a competition sponsored by the *American Institute of Electrical Engineers*, for their paper on "Noise Evaluation of Fluorescent Lamp Ballasts."

The *Illinois Institute of Technology* has issued several announcements regarding its personnel and a meeting. Dr. Ralph G. Owens was named assistant dean of engineering, succeeding Chester A. Arents, who



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CRUCIBLES • DISHES TRAYS

VITREOUS SILICA — VITREOSIL

Immune to Extreme Chemical, Thermal and Electrical Conditions. Non-catalytic. Non-porous.

VITREOSIL CRUCIBLES permit the production of compounds of real purity; and do not absorb material. It is possible to wind Vitreosil Crucibles with wire for direct electrical heating. Made in glazed and unglazed finish.

VITREOSIL DISHES for concentrating, evaporating and crystallizing acid solutions. Made in large and small sizes and types as required.

VITREOSIL TRAYS are made in two types; four sided with overflow lip at one end for continuous acid concentration; and plain. Our Technical Staff places itself at your disposal for further data. For details as to sizes, prices, etc.,

Write for Bulletin No. 8

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ENGELHARD

meets every

THERMOCOUPLE NEED!

Noble Metal Thermoelements and Thimbles

platinum vs. platinum-rhodium—repaired at substantial savings, with credit for reclaimed metal.

Base Metal Thermoelements

chromel vs. alumel iron vs. constantan copper vs. constantan

Standard Insulators

All types and sizes

Primary and Secondary Protection Tubes

Terminal Heads and Lead Wire, etc.

At Engelhard, you will find a complete line of thermocouples and accessories to meet all requirements. The individual parts of Engelhard thermocouples are selected and assembled for your specific conditions of atmosphere and temperature. You can rely on Engelhard's more than 40 years of research and instrument-building experience to solve your temperature measurement problems. Write for complete information today.

CHARLES ENGELHARD, INC.

850 PASSAIC AVE., EAST NEWARK, N. J.

News Digest

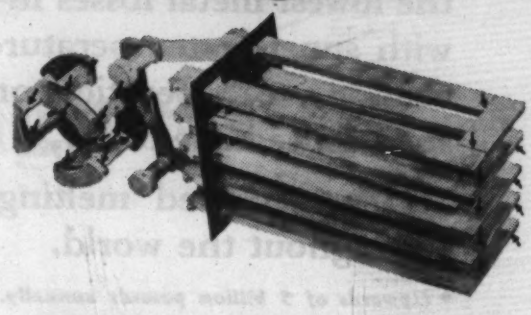
was recently made coordinator of research. Dr. Owens has served as professor of mechanical engineering at Illinois Tech since 1946. Charles E. Lundin, assistant metallurgist, was awarded second prize by the American Institute of Mining & Metallurgical Engineers for his technical paper on "Corrosion Fatigue of Alloy Steels". A Symposium on Analysis and Metallography of Titanium will be held by the Institute on June 11-13 at the Sheraton Hotel in Chicago. Program chairman is Dr. Julian Glasser, research metallurgist at the Foundation. From June 14-16 a Symposium on Surfaces will be conducted, with Charles F. Tufts, associate physicist, and Dr. Walter C. McCrone, supervisor of analytical chemistry, acting as program chairmen.

The next private seminar on the organization and operation of company standardization work will be held by Dr. John Gaillard in the Engineering Societies Bldg., New York City, from June 18-22, 1951. The seminar is sponsored by the *American Standards Assn.*, and those interested in attending may phone Dr. Gaillard at the Association's headquarters, or write him direct at 400 W. 118 St. New York 27.

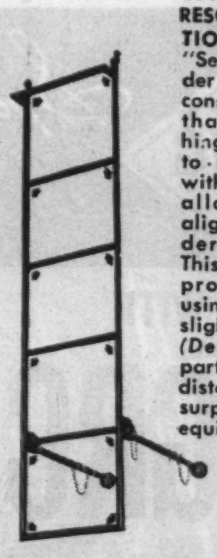
A special course in infra-red spectroscopy will be offered jointly by the Spectroscopy Laboratory and the Dept. of Chemistry at the *Massachusetts Institute of Technology* during the 1951 Summer Session. Two identical one-week programs will be offered July 9 and July 16. The course is restricted to those having the bachelor's degree and some research experience. Further information may be obtained from Professor Walter H. Gale, director of the M.I.T. Summer Session.

The *Institute of the Aeronautical Sciences* has presented a number of awards recently. Brigadier-General Otis A. Benson, Jr., U.S.A.F. (M.C.) received the John Jeffries Award for 1950 for outstanding contributions to the advancement of aeronautics through medical research. Robert R. Gilruth, chief of the Pilotless Aircraft Research Div., Langley Aeronautical Laboratory, National Advisory Committee for Aeronautics, was the recipient of the Sylvanus Albert Reed Award for 1950, in recognition of his conception and development of new techniques for obtaining transonic and supersonic data using freely flying models. The Robert M. Losey Award for 1950 was presented to Roscoe R. Braham, Jr., of the U. S. Weather Bureau, in recognition of outstanding contributions to the science of meteorology as applied to aeronautics. And finally, Frank N. Piasecki, of the Piasecki Helicopter Corp., was named to receive the Lawrence Sperry Award for 1950 "for a notable contribution made by a young man to the advancement of aeronautics".

FREE Low Temperature **EUTECTIC** WELDING ALLOYS **DATA FILE PROVES SAVINGS YOU CAN ENJOY IN PRODUCTION WELDING**



EUTECROD 1800 DOES "IMPOSSIBLE" JOB WITH EASE. In the magnet charger shown above, 23 copper joints had to be welded *without distortion*, for the cumulative effect of even the slightest warpage per joint would ruin the job. This seemingly impossible metal-joining problem was easily solved with EutecRod 1800—the fast-flowing, high conductivity, high strength "Eutectic Low Temperature Welding Alloy" that welds steel, copper, and nickel units that demand *distortion-free* elasticity. *(Write for complete data.)*



EUTECROD 16 STRENGTHENS RESCUE LADDER CONSTRUCTION. The Curtiss-Wright "Seahawk" collapsible ladder shown in the photo is constructed in cross-sections that swing together on hinges. Previous attempts to weld the ladder joints with conventional high-heat alloys resulted in misaligned structure that rendered the ladder unsafe. This unusual metal-joining problem was solved by using new EutecRod 16 and slight design modification. *(Details on request.)* The parts thus joined remained distortion-free and strong, surpassing the rigid Navy equipment requirements.

"EUTECTIC Low Temperature WELDING ALLOYS" are setting new standards for production and maintenance welding everywhere. Drawbacks of conventional brazing and fusion welding—such as distortion, warping, porosities, and weld failures — are minimized or completely eliminated when you use EUTECTIC's JOB PROVED hi-tensile low melting alloys.

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Technical Information Section

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No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

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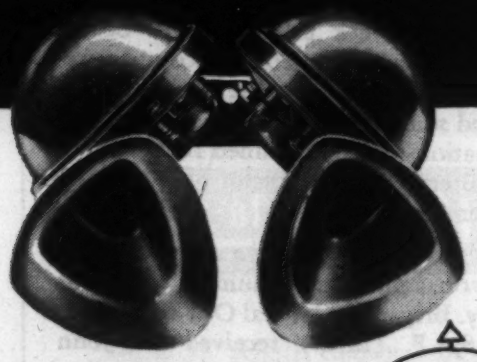
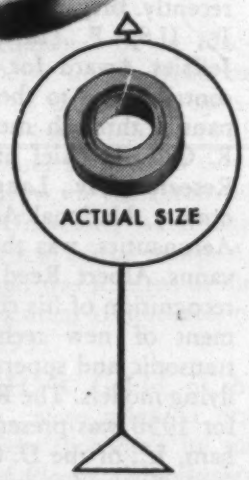


TINY ZINC DIE CASTINGS



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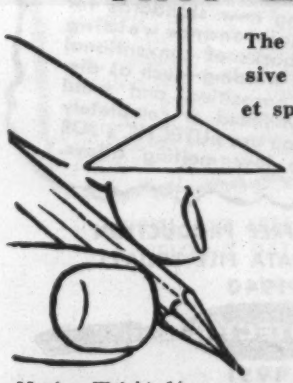

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Meetings and Expositions

AMERICAN CERAMIC SOCIETY, annual meeting. Chicago. April 22-26, 1951.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. Buffalo, N. Y. April 23-26, 1951.

METAL POWDER ASSOCIATION, annual meeting and exhibit. Cleveland. April 25-26, 1951.

ASSOCIATION OF IRON & STEEL ENGINEERS, spring conference. Detroit. April 30-May 1, 1951.

MATERIALS HANDLING EXPOSITION. Chicago. April 30-May 4, 1951.

INDUSTRIAL FASTENERS INSTITUTE, annual meeting. Hot Springs, Va. May 3-4, 1951.

COPPER & BRASS RESEARCH ASSOCIATION, annual meeting. Hot Springs, Va. May 6-9, 1951.

NATIONAL WELDING SUPPLY ASSOCIATION, annual convention. Cleveland. May 7-9, 1951.

GREATER NEW YORK INDUSTRIAL SHOW. New York. May 7-11, 1951.

ENGINEERING INSTITUTE OF CANADA, annual meeting. Montreal. May 9-11, 1951.

INDUSTRIAL FURNACE MANUFACTURERS ASSOCIATION, annual meeting. Hot Springs, Va. May 14-16, 1951.

LEAD INDUSTRIES ASSOCIATION, annual meeting. New York. May 17-18, 1951.

AMERICAN ZINC INSTITUTE, annual meeting. St. Louis. May 21-22, 1951.

INTERNATIONAL ACETYLENE ASSOCIATION, annual convention. Montreal. May 21-23, 1951.

AMERICAN IRON & STEEL INSTITUTE, general meeting. New York. May 23-24, 1951.

AMERICAN SOCIETY FOR QUALITY CONTROL, annual convention. Cleveland. May 23-24, 1951.

SOCIETY OF THE PLASTICS INDUSTRY, annual national meeting. White Sulphur Springs, W. Va. May 24-25, 1951.

CANADIAN INTERNATIONAL TRADE FAIR. Toronto. May 28-June 8, 1951.

METAL TREATING INSTITUTE, spring meeting. Glenwood Springs, Colo. May 30-June 2, 1951.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. French Lick, Ind. June 3-8, 1951.

AMERICAN GEAR MANUFACTURERS' ASSOCIATION, annual meeting. Hot Springs, Va. June 4-6, 1951.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Toronto. June 11-15, 1951.

SECOND ANNUAL CONFERENCE ON INDUSTRIAL RESEARCH. New York. June 11-15, 1951.

RAILROAD DESIGNERS KNOW...

Bronze Journal Bearings Have Highest Fatigue Strength and Load Carrying Capacity

Performance of railroad journal bearings, under heavy load applications at relatively low speeds, can not be anticipated by the usual physical tests of tensile strength, elongation, etc. Since it is impossible to maintain a perfect oil film between the rotating journal and bearing, the behavior of bearing metals under momentary *metal-to-metal* contact becomes a major distinguishing characteristic.

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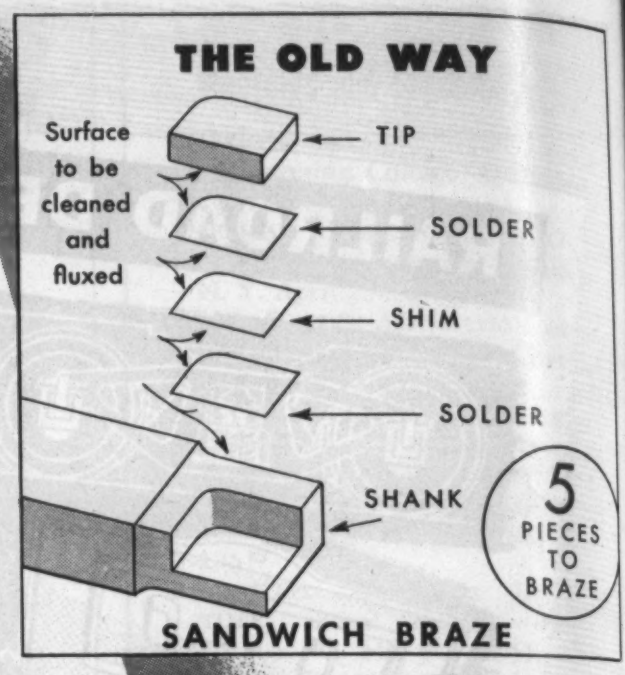
Problem:

How to Speed Up Sandwich Brazing Carbide Tool Tips



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Carbide tipped tools give best results if the tip is brazed to the shank by sandwich brazing. However, the disadvantage of this method is the work involved in cleaning, fluxing, and positioning the three separate pieces of brazing alloy and shim material in addition to the tip and shank.

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MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Constructional Alloy Steels. Bliss & Laughlin, 46 pp, Sec. X. Detailed technical data on the effects of alloying elements on the properties of SAE and AISI cold finished steels. (1)

Steel Design. Climax Molybdenum Co., 72 pp. Booklet tells how to combine good design, quality steel and proper treatment for best results with steel components. (2)

Stainless Steel. Crucible Steel Co. of America, 31 pp, ill. Shows, through applications in textile industry, savings available to users of stainless steel. (3)

Gray Cast Iron. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (4)

Mold and Die Steel. W. J. Holliday & Co., 4 pp, ill, No. 905. Description of properties, advantages and other features of Speed Alloy steel mold and die plate. (5)

Stainless-Clad Steel. Ingersoll Div. of Borg-Warner Corp. Folder describes Ing-Aclad, 20% cladding of stainless steel bonded to backing of carbon steel. (6)

Low Alloy Steel. Inland Steel Co. Data on easy-to-fabricate Hi-Steel, strong, abrasion and corrosion resistant structural steel with high fatigue strengths. (7)

Abrasion Resistant Alloy. Jones & Laughlin Steel Corp., 36 pp, ill, No. AD155. Mining and earthmoving applications of Jalloy, abrasion and impact resistant steel. Gives technical data. (8)

Screw Steel. Joseph T. Ryerson & Son, Inc., 2 pp. Describes Ledloy, claimed to machine 30 to 50% faster than the fastest cutting screw steel previously available. (9)

Low Alloy and Stainless Steels. Sharon Steel Corp., 4 pp, ill, No. 1a-26. Details of company's stainless, high tensile, low alloy steels, Cor-Ten and N-A-X. (10)

Ferro-Alloys and Metals. Vanadium Corp. of America, 24 pp, ill. *The Vancoram Review* presents technical articles on applications and developments in ferro metallurgy concerned with vanadium alloys. (11)

Non-Slip Steel Plate. Alan Wood Steel Co., 8 pp, ill. Specifications and characteristics of Algrip abrasive-rolled steel floor plate designed for non-skid applications. (12)

Nonferrous Metals

Continuous Cast Bronzes. American Smelting and Refining Co. Catalog with physical properties, table of stock shapes and sizes, weights and photomicrographs of Asarco continuous cast bronzes. (13)

Beryllium Copper. The Beryllium Corp. Monthly technical bulletins on uses of, and developments in beryllium copper. (14)

Low Temperature Melting Alloys. Cerro de Pasco Copper Corp. Technical data and applications of Cerro low temperature melting alloys useful in many phases of industry. (15)

Low-Expansion Alloy. Chicago Developments Corp., 1 p, No. 50. Brief properties of low-expansion alloy CDC-50, without nickel, suitable for many uses of nickel-irons. (16)

Aluminum Alloy. Frontier Bronze Corp. Data on Frontier 40-E aluminum alloy combining high strength, good shock and corrosion resistance, and machinability. (17)

Welding Nickel Alloy. Illium Corp., 4 pp, No. 105B. Instructions for metallic arc and oxyacetylene gas welding of Illium, nickel-base, corrosion resistant alloy. (18)

High Temperature Alloy. The International Nickel Co., Inc. *Keep Operating Costs Down When Temperatures Go Up* shows applications of Inconel to high temperature service. (19)

Titanium Carbide. Kennametal, Inc., 4 pp, ill, No. 1050. Description and properties of Kentanium, titanium carbide with high heat and thermal shock resistance. Describes forming methods. (20)

Bronze Bearing Metal. National Bearing Div., 6 pp, ill. Stock sizes of "Tiger" bronze bearing metal said to be easy to machine, wear resistant, anti-frictional, and shock resistant. (21)

Aluminum. Reynolds Metals Co., 4 pp, ill. *Reynolds Metals Technical Advisor* gives latest developments in fabrication and processing of aluminum and its alloys. (22)

Nonferrous Alloy Specifications. The Riverside Metal Co. Correlations of ASTM, Federal, Army and Navy Specifications for 40 nonferrous alloys. Includes characteristics, available forms and uses. (23)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 177.

Nonmetallic Materials • Parts

Rubber Parts. Acushnet Process Co., New Bedford, Mass. Rubber handbook shows wide variety of rubber parts typifying products company can make to order. Request from Acushnet on company letterhead.

Felt Parts. American Felt Co., folder, ill. Describes custom-made cut felt parts with applications, including separating, protecting, sealing, polishing and insulating. (24)

Hard Rubber and Plastics. American Hard Rubber Co. Handbook of company's hard rubbers and plastics, describing properties and typical uses. (25)

Plywood. Douglas Fir Plywood Assn. *1000 Uses for Douglas Fir Plywood* describes various applications in industry to which plywood can be put. (26)

Flexible Tubing. Flexible Tubing Corp. Bulletin shows numerous uses, features and available sizes of Spiratube flexible tubing. (27)

Laminated Plastic Parts. The Formica Co. Catalog gives full information on company's facilities for complete machining of Formica custom made parts. (28)

Plastics. General Electric Co., Plastics Div., 16 pp, ill, No. 16/13. Characteristics, uses and properties of this company's various molded and laminated plastics. (29)

Rubber. B. F. Goodrich Chemical Co. Properties and applications of Hycar, high strength compression and heat resistant rubber suited to heavy duty service. (30)

Rubber Reinforcing Resin. Goodyear Tire & Rubber Co., Chemical Div., No. 601-B. Features and applications of Pliolite S-6B resin giving greater plasticity in rubber processing at low temperatures. (31)

Insulating Sheet. Laminated Plastics, Inc., ill. Property data and comparison charts on Glastic MM, Fiberglas reinforced laminate with high strength and heat resistance for electrical insulation. (32)

Apparatus Porcelain. Locke Inc., 12 pp, ill, No. 518. Discusses characteristics and limitations of ceramic processes as an aid to designing porcelain apparatus. (33)

Metal Hydrides. Metal Hydrides, Inc. Describes various metallurgical hydrides for use in conserving metals subject to oxidation in air and producing powder metal alloys. (34)

Carbon Products. Morganite, Inc., 8 pp, ill, No. 1f. Specifications of various carbon bearings and bushings. Also properties of six series of Morganite carbon products. (35)

MANUFACTURERS' LITERATURE

Impact Phenolics. The Rogers Corp. Shows various types of Fiberloys, including molding compounds in sheet and bulk form, laminated plastics and paperboards. (36)

Clear Plastic. Rohm & Haas Co., 24 pp, ill, No. PL-78. Describes Plexiglas, lightweight, strong, clear, weather resistant acrylic plastic and fabricating techniques for architectural uses. (37)

Cellular Rubber. Rubatex Div., Great American Industries, Inc., No. RBS-12-49. Features of Rubatex closed cell rubber for cushioning, gasketing and shock-absorbing. (38)

Synthetic Rubber. Rubber Chemical Div., E. I. du Pont de Nemours & Co., Inc., 12 pp, ill, No. 43. Uses of Neoprene in parts requiring high chemical resistance. (39)

Rubber Compounds. The Stalwart Rubber Co., 16 pp, ill, No. 51SR-1. Shows broad range of rubber compounds, their properties and facilities for custom manufacture of rubber parts. (40)

Ceramics. Stupakoff Ceramic & Manufacturing Co., 4 pp, No. 849. Properties of Stupalith, new ceramic said to be unsurpassed in thermal shock resistance. (41)

Technical Plastics. Synthane Corp., 20 pp, ill, No. 16/15. Properties, available forms, specifications and applications of this company's technical plastics described. (42)

Inert Plastic. U. S. Gasket Co., Teflon Products Div., No. 300. Description and specifications of available stock of Teflon, chemically inert, electrically resistant plastic. (43)

Carbon Graphite. U. S. Graphite Co., 4 pp, ill. Describes Graphitar, carbon-graphite nonmetallic that is chemically resistant, self-lubricating, hard, light and won't warp. (44)

Polyvinyl Resins. U. S. Rubber Co., Naugatuck Chemical Div., 20 pp, ill. Properties, ingredients compounding and processing of Marvinol polyvinyl chloride resins. (45)

Plastics Parts. Watertown Manufacturing Co. 44 pp, ill. Complete data on properties and applications of plastics produced by this company. (46)

Nonmetallic Gears. Westinghouse Electric Corp., 15 pp, ill, No. B-4661. Description and applications of Micarta gears. Includes tables of properties, gear data and preferred pitches. (47)

Metal Parts • Forms

Precision Investment Castings. The Adapti Co., 4 pp, ill. Close tolerances and stronger metals listed among advantages for parts made by Adapti method of precision casting. (48)

Precision Castings. Alloy Precision Casting Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts made to order. (49)

Aluminum Die Castings. Aluminum Co. of America. Book contains detailed technical information for effective design of aluminum die castings. (50)

Aluminum Extrusions. Aluminum Co. of America. Design potentials of extrusion process and cost savings in fabrication and assembly of extrusions explained. (51)

Aluminum Parts. Aluminum Goods Manufacturing Co., 56 pp, ill. Catalog covers extensive production facilities and technical services for producing wide range of parts. (52)

Plated Metal Parts. American Nickeloid Co., ill. Indicates wide variety of economies available to users of preplated metals for parts manufacture. (53)

Precision Castings. Austenal Laboratories, Inc., Microcast Div., 16 pp, ill. Describes Microcast Process for manufacture of precision cast parts, including specifications and explanation. (54)

Small Parts. The Bead Chain Manufacturing Co., 12 pp, ill. Specifications and designs of small electronic contact pins, terminals, leads and jacks showing typical available Multi-swage products. (55)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Specifications, advantages and list of applications of various types of welded steel tubing. (56)

Magnesium Parts. Brooks and Perkins, Inc. Table of magnesium alloy characteristics, design helps and pictures of magnesium products produced by B & P. (57)

Stainless Tubing. Carpenter Steel Co., Alloy Tube Div., 4 pp, ill. Physical properties, corrosion resistance and available sizes of this company's stainless tubing. (58)

Heat Resistant Castings. Chicago Steel Foundry Co. Properties of Pyrasteel, chromium-nickel alloy designed for resistance to high temperatures, corrosive gases and most commercial acids. (59)

Metal Stampings. Dayton Rogers Manufacturing Co., 4 pp, ill. Describes low cost process for producing metal stampings in small lots. Shows costs of several example jobs. (60)

Magnesium Forms. Dow Chemical Co., Magnesium Div. Technical information on magnesium, its available forms and applications. (61)

Forged Metal Quality. Drop Forging Assn., 6 pp, ill. Details of several hot working processes emphasizing improvements achieved in metal structure using these processes. (62)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (63)

Heat Resistant Castings. Electro-Alloys Div., American Brake Shoe Co., 57 pp, ill, No. T-155. Detailed properties and applications of Thermalloy and Chemalloy heat, abrasion and corrosion resistant alloys. (64)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pp, ill. Properties and advantages of graphalloy grades for bushings and electrical uses. Includes bearing design data. (65)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision cast brass, bronze, beryllium copper and steel. (66)

Die Castings. The Hoover Co., ill. Booklet gives overall picture of die casting industry stressing low costs of die castings, design hints and production methods. (67)

Beryllium Copper Springs. Instrument Specialties Co., 12 pp, ill., No. 6. Catalog shows typical applications of beryllium copper springs and electrical contacts. Includes price list and properties of beryllium copper. (68)

Precision Die Castings. The Jelrus Co., Inc., 4 pp, ill. Case histories illustrating cost savings in parts manufacture through application of nonferrous precision die casting methods. (69)

Aluminum Cable. Kaiser Aluminum & Chemical Corp. Properties of Kaiser Aluminum ACSR and All-Aluminum Cable. Gives tables of reel sizes. (70)

Centrifugal Steel Castings. Lebanon Steel Foundry, 8 pp, ill. Describes centrifugal casting process for producing many symmetrical steel shapes at low costs with great accuracy. (71)

Aluminum Extruded Shapes. Light Metals Corp., 6 pp, ill. Shows facilities for producing to order a variety of indicated aluminum fabrications and extruded shapes. (72)

Cold Drawn Shapes. Linde Air Products Co., 2 pp. Types, materials and dimensional ranges of available Prest-O-Lite cold-drawn shapes and shells. (73)

Die Castings. Litemetal Die Cast, Inc., 12 pp, ill. How to select best light metal for die casting. Shows facilities for producing light metal pressure die castings. (74)

Gray Iron Castings. Meehanite Metal Corp., 8 pp, ill, No. 31. Engineering data on casting plus specific applications showing capabilities of Meehanite gray iron castings. (75)

Sintered Metal Bearings. Michigan Powdered Metal Products, Inc., 2 pp, ill. Describes sintered metal bearings with cavities in bearing walls to enable greater oil content and heavier bearing loads. (76)

Seamless Tubing. National Tube Co. Booklet describes numerous applications of Shelby seamless steel tubing. (77)

Zinc Die Castings. The New Jersey Zinc Co., 8 pp, ill. *The Alloy Pot* gives monthly developments and applications of zinc die casting. (78)

Precision Casting. Ohio Precision Castings, Inc., 12 pp, ill. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium copper plaster mold castings. (79)

Seamless Tubing. The Ohio Seamless Tube Co., 12 pp. ill. Shows differences in fabrication of such tubings as mechanical seamless, aircraft seamless, resistance welded and forged, listing advantages and applications. (80)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, ill. Describes

MANUFACTURERS' LITERATURE

die casting. (144)

Powder Metallurgy Presses. Kux Machine Co., ill. Catalog shows complete line of presses designed for powder metallurgy, giving specifications and features. (146)

Tungsten Carbide Blades. Metal Carbides Corp., No. 48WP. Prices, specifications and sizes of Talide tungsten carbide centerless blades claimed to have exceptionally long life. (147)

Wire Straightening Machines. Mettler Machine Tool, Inc., 4 pp, ill. Operating instructions for, and advantages of five types of Shuster wire straightening and cutting machines. (148)

Die Casting Machines. Reed-Prentice Corp. Circulars describe this firm's die casting machines for zinc and aluminum casting. (149)

Metal Notching Units. Wales-Strippit Corp., ill, No. N. Shows complete line of notching units for rapid notching of sheet metals showing example setups and advantages. (151)

Adjustable Perforating Dies. S. B. Whistler & Sons, Inc. Catalog describes this company's line of adjustable perforating dies for punching holes in sheet metals. Includes prices and applications. (152)

Inspection • Testing • Control

Hardness Testers. Ames Precision Machine Works, 6 pp, ill. Features, operating instructions and applications of portable precision hardness testers reading directly in Rockwell scales. (153)

Testing Machine. Baldwin-Lima-Hamilton Corp., 4 pp, ill, No. 310. Features and specifications of Model 60-H universal testing machine, said to have 60,000-lb capacity. (154)

Ultrasonic Tester. The Brush Development Co., 4 pp, ill. Operating principle and uses of the "Hypersonic" Analyzer for nondestructive inspection of materials. (155)

Specimen Grinders. Buehler Ltd., 6 pp. Describes belt and wheel type grinders and surfacers for wet or dry grinding of metallographic specimens. (156)

Industrial Radiography. Eldorado Mining & Refining (1944) Ltd., Dept. W. Up-to-date information on nondestructive testing of metals by gamma radiography. (157)

Batch Mixer for Testing. Claud S. Gordon Co., 1 p, ill. Shows 4-qt stainless steel batch mixer for mixing small amounts of sample mixtures for test purposes. (158)

Temperature Control. Illinois Testing Laboratories, Inc. Description, wiring diagrams and applications of Alnor Pyrotac excess temperature cut-off. (159)

Microphotometer. Jarell-Ash Co., No. 1-5. Specifications for Jaco projection comparator microphotometer, with many advantages to the spectrographer. (160)

Universal Testing Machines. National Forge & Ordnance Co., Testing Machine Div., No. 501. Specifications, capacities and operating principle of table model universal testing machines. (161)

Portable Hardness Tester. Newage International, Inc., 4 pp, ill, No. ET. Features and operating principle of Ernst portable hardness tester giving direct readings in three scales and usable on any sized piece. (162)

Radiation Pyrometer. The Pyrometer Instrument Co., No. 100. Features and principle of Pyro radiation pyrometer for obtaining spot temperatures in furnaces, kilns, forgings and fire boxes. (164)

Radiography. The Radium Chemical Co., Inc., 48 pp, ill. Details of radium radiography explaining the nature of the equipment and method, recommended techniques and aids to interpreting results. (165)

Tensile Testing Machines. Scott Testers, Inc., 66 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strengths of materials such as rubber, paper, wire and thread. (166)

Universal Testing Machine. Steel City Testing Machines, Inc., 2 pp, ill. Features of Model MP-10 machine for tensile, transverse and compression testing up to 60,000-lb capacity. (167)

Pyrometers. Tagliabue Instrument Div., 34 pp, ill, No. 1101 J. Detailed data on Celectray thermal indicating or recording controllers and accessories designed for high sensitivity and accuracy. (168)

Plastics Tests. U. S. Testing Co., Inc., 2 pp. Price list of physical, chemical, microbiological and permanence tests available for plastics film, sheeting and coated fabrics. (169)

Hardness Testers. Wilson Mechanical Instrument Co., 44 pp, ill, No. RT-46. Descriptions and features of available Rockwell hardness testers and accessories. Shows operating techniques and principles. (170)

General

Underground Corrosion Protection. Federated Metals Div., folder. Discusses causes of underground corrosion, and describes magnesium anodes for giving long-term protection. (172)

Inventory Controls. Remington Rand Inc., No. KD 367. Describes Kardex inventory controls designed for such uses as coordinating materials inventories with production requirements. (173)

Vacuum Processing Equipment. F. J. Stokes Machine Co., 32 pp, ill, No. 700. Describes Microvac pumps for high vacuum processes, such as creation of inert atmospheres for heat treating metals and metal powders. (174)

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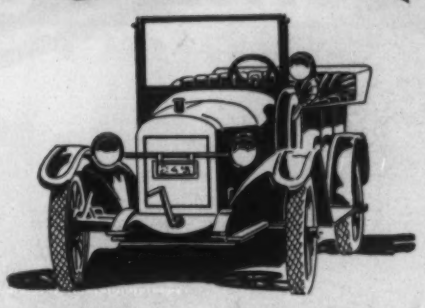

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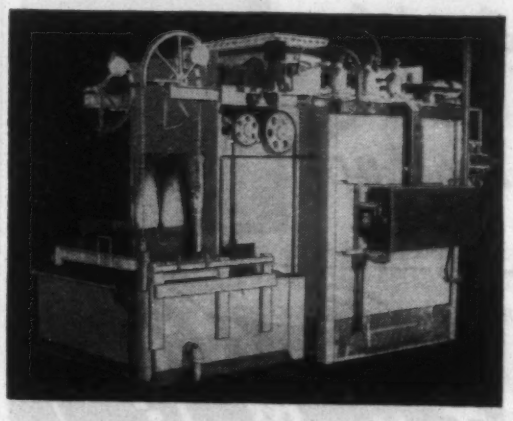
CASE HISTORY OF DOW HEAT TREATING PERFORMANCE ON SHIFTER SHAFTS AT TRACTOR PLANT

Heat Treatment: .005"–.008" effective case, carbonitrided 1500°F, Oil Quench, File Hard

Load: 640 Shifter Shafts, Fixture loaded, 1024 lbs. net–1384 lbs. gross
Heating Time: 70 minutes Total Furnace Time: 2 hours 10 minutes
Net Production: 472 lbs. per hour



By processing these parts in the Dow Furnace, distortion is reduced sufficiently to permit elimination of the grinding operation after heat treating. Since no case is removed by grinding, the specified depth of case is reduced, effecting still further savings in heat treating costs. Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, contribute to savings which can amortize the original cost of your Dow Furnace in a few months.

DOW FURNACE OFFERS

- Gas cyaniding for ⅓ to ¼ the cost of liquid cyaniding
- Uniformity of light case depths throughout load
- Unmatched versatility—gas cyaniding, gas carburizing, clean hardening or carbon restoration
- Improved quality. Forced, uniform quenching gives full hardness, reduced distortion.
- Maximum capacity with minimum investment and floor space

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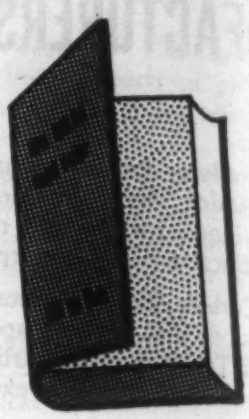

BOOK REVIEWS

TENTATIVE METHOD FOR DETERMINATION OF BENDING STRENGTH, GREEN DENSITY, HARDNESS AND SHRINKAGE OF COMPACTED SINTERED METAL POWDER SPECIMENS. *Published by the Metal Powder Assn., New York 17, N. Y., 1951. Paper, 6 by 9 in., 4 pages. Price 25¢.* MPA Standard 13-51T describes a testing procedure for determining the as-sintered bending strength (modulus of rupture) where applicable, the green density, sintering shrinkage or expansion, and the as-sintered hardness of compacted and sintered metal powder specimens.

QUALITY CONTROL—PRINCIPLES, PRACTICE AND ADMINISTRATION. *By A. V. Feigenbaum. Published by McGraw-Hill Book Co., New York 18, N. Y., 1951. Cloth, 6¼ by 9¼ in., 443 pages. Price $7.00.* A quick-reference guide for improving product quality and design and for reducing operating costs and losses, both from an organization-administrative and from a technical point of view.

SYMPOSIUM ON ULTRASONIC TESTING. *Published by the American Society for Testing Materials, Philadelphia 3, Pa., 1951. Paper, 6 by 9 in., 120 pages. Price $2.00; to ASTM member, $1.50.* Special Technical Publication No. 101, prepared by the ASTM Committee E-7 on Non-Destructive Testing, contains all the papers presented at the 1949 annual meeting, together with one earlier paper and two offered subsequently.

TENTATIVE METHOD FOR SUBSIEVE ANALYSIS OF GRANULAR METAL POWDERS BY AIR CLASSIFICATION. *Published by the Metal Powder Assn., New York 17, N. Y., 1951. Paper, 6 by 9 in., 4 pages. Price 25¢.* MPA Standard 12-51T is a method for the particle size analysis and fractionation of granular metal powders primarily in the subsieve range (1 to 40 microns) using air or gas elutriation. It is not suitable for fractionation within the 0-5 micron range.

COSTS, BUDGETING AND ECONOMICS OF INDUSTRIAL RESEARCH. *Edited by David B. Hertz. Published by King's Crown Press, New York 27, N. Y., 1951. Paper, 5½ by 8½ in., 261 pages. Price $4.50.* The first annual conference on industrial research, sponsored by the Dept. of Industrial Engineering, Columbia University, was held in June 1950. All the papers delivered at the conference discussing costs, budgeting and economics of industrial research, and the informal clinic session that followed them, are contained in this book.

SYMPOSIUM ON PLASTICITY AND CREEP OF METALS. *Published by the American Society for Testing Materials, Philadelphia 3, Pa., 1950. Paper, 6 by 9 in., 68 pages. Price $1.50.* Four outstanding phases of the plastic deformation and flow of metals are included in this Special Technical Publication No. 107, which contains all the papers presented at the first Pacific area national meeting, held in San Francisco on Oct. 10, 1949.

INTRODUCTION TO MECHANICAL DESIGN. *By T. B. Jefferson and Walter J. Brooking. Published by The Ronald Press Co., New York 10, N. Y., 1951. Cloth, 6¼ by 9¼ in., 612 pages. Price $6.50.* A textbook that has not only a completeness from the practical viewpoint, but also that follows much more closely the mode of creative thinking of engineers who are actually designing machines, rather than simply considering their elements as individual and separate theoretical problems.

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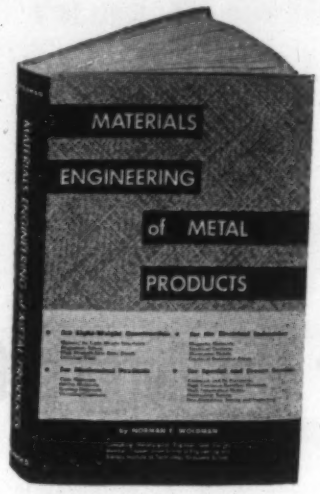

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The Editor's Page

Powder Metallurgy's Challenge

According to early reports, the Metal Powder industry is about to be presented with a challenge much greater than has ever faced the infant industry. Actually, there are three challenges.

The first challenge is concerned with meeting the heavy demands for powder metal parts for ordnance uses. Only one item—iron powder rotating bands—has released a torrent of figures. We hear that the total needs may exceed 10 million lb of iron powders per month. Of this, about half is earmarked for rotating bands under projected production programs. If these figures are accurate, the capacity for powders, as well as for finished parts, will have to be increased many times—and in a hurry.

Next, we hear that many in the metal powder industry are suggesting the use of metal powder parts as replacements for parts formerly made of scarce materials. This is admirable, and undoubtedly there will be many instances where replacements, or substitutes, will serve better than the original parts. At least this can be true if only those jobs are undertaken which truly belong to powder metallurgy.

The combination of the first two points brings us to the final and greatest challenge: With the opportunities now being presented to the metal powder industry, will the industry establish for itself a permanent high place in industry.

To review, during the last war the field was busy and made many important parts—some of which could have been made otherwise only with great difficulty or at much greater cost. When the war ended, the amount of business dropped down to a fraction of what it had been. The fault probably lies in the collective lap of the industry.

Because of the attitudes of many factors in powder metallurgy, the entire business has taken on an aura of deep mystery. This, more than any one thing, we suspect, caused parts buyers to drift back to more conventionally produced parts.

As insurance against recurring feast and famine periods, it would seem that the metal powder industry might unite and embark upon a form of public relations aimed at taking the mystery out of the entire field. It is highly unlikely that the customers of plants presently producing metal powder parts will go into the business themselves. On the other hand, anyone who wants to can hire enough trained people to achieve a working knowledge of the field.

A few years ago, in this space, we commented that the industry had an ostrich-like attitude. There has not been a great change in this attitude. True, there has been a little more information released by individuals in the industry, but by and large, it is the least communicative of the industries with which we deal.

We, personally and editorially, believe that there is a great future for powder metallurgy. Work already done convinces us of this. However, powder metallurgy is going to come out of the present emergency in a vastly expanded condition. To keep from falling completely apart, there will be needed an aggressive and intelligent selling campaign to compete with the efforts of those processes which are competitive.

Now is not too soon to start selling and, again in our opinion, the best way to start selling is to remove all elements of mystery. Buyers want to know what they are buying and why it is that way.

T. C. Du Mond
Editor